

Effect of high shear rates on physico-chemical characteristics, rheological behavior and fouling propensity of orange juices during cross-flow microfiltration

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Microfiltration is broadly used in fruit juices industries to ensure clarification and sterilization of many fruit juices or to concentrate their pulpy fraction. However, the industrial application of microfiltration in fruit juice industries remains hampered by the decrease of membrane permeability during the operation, due to the fouling mechanism. To increase technological feasibility and economical productivity, fruit juices microfiltration is generally performed using tubular membrane under high crossflow velocities, with the aim to limit particles deposition. Indeed, high shear rates close to the membrane surface can reduce membrane fouling by reducing particles deposition, but under these hydrodynamic conditions large compounds, present in the bulk suspension, can be fractionated into smaller particles. Since fruit juices contain cell fragments, colloidal aggregates, etc. this fractionation can release new compounds characterized by a high fouling propensity.

The aim of this work was to study the impact of high crossflow velocity on orange juice characteristics, i.e. particles size distribution, insoluble particles cohesion energy and overall fouling propensity.

A raw orange juice (produced locally) was subjected to a shear rate of 2.10^3 s^{-1} (without filtration) using a pilot-scale filtration unit (TIA, Bollène, France). Laser diffraction was used to determine the impact of this shear rate on the particles size distributions of the orange juice. Dynamical rheological measurements, according to the strain amplitude sweep test, were realized on the insoluble compounds of the raw and the sheared juices. The obtained complex moduli and critical yield stresses were used to calculate the energy of cohesion of the network of this class of particles. Finally, the fouling propensities of the raw and the sheared juices were determined using a stirred and pressurized lab-scale filtration cell.

The obtained results showed that the crossflow velocity changed significantly the properties of the orange juice. Indeed, large particles were not only removed from the membrane wall but also divided into smaller particles. Moreover, rheological measurements showed that higher network particles strength took place after subjecting the juice to a cross-flow velocity, suggesting that the fractionation of large particles released smaller compounds leading to higher particles-particles interactions. Furthermore, filterability tests confirmed that the fouling propensity of fractionated juice was different from that of the raw one. These results show that the subjecting orange juices to high crossflow velocities during microfiltration can generate small particles and subsequently enhance the membrane fouling. According to this conclusion, new filtration configurations such as using hollow fiber membrane (dead-end filtration mode) and softer operating conditions could be proposed as an interesting alternative to the conventional fruit juices microfiltration conditions.

Keywords: orange juice, crossflow microfiltration, membrane fouling, fouling propensity

Book of Abstracts



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Book of Abstracts

The Food Factor I Barcelona Conference, 2-4 November 2016, Barcelona (Spain)



INTRODUCTION

This book contains a selection of the abstracts that were accepted for presentation at The Food Factor I Barcelona Conference, Established, emerging and exploratory food science and technology, which was held at the University of Barcelona, Spain, from 2 to 4 November 2016.

The first edition of this Food Factor Conference gathered around 250 participants, coming from more than 45 countries. And around 280 works were presented at the conference. This was a more than satisfactory level of attendance for this first research forum, especially in the context of a global budget constraint.

The organization called for research papers dealing with the following topics:

Food chemistry and biochemistry

Topics: structure and function of major and minor components (either nutrient or non-nutrient) of foods, the biochemical changes produced during handling, storage, post-harvest/mortem processing, distribution or due to domestic conditions, and their impact on nutritional, physiological, sensorial, or toxicological properties and safety; Reports on new or improved techniques or methods for addressing these topics or on the chemistry of food contacting materials. Specific areas of interest were:

- Food bioactives
- Chemistry of food additives and preservatives
- Chemical analysis for the determination of authenticity and origin of foods
- Biochemical changes in cereal grains and legumes due to postharvest conditions and treatments (storage, germination, fermentation...)
- Biochemical changes in postharvest fruits and vegetables with impact in quality
- Biochemical changes produced in the conversion of muscle into meat and fish
- Biochemistry of the biosynthesis of milk components
- Biochemical changes of the transformation of milk into dairy products
- Browning reactions in foods
- Lipid peroxidation
- Computational chemistry in food research
- Chemistry of food packaging and food-handling materials

Food microbiology

Topics: microorganisms that are related to human nutrition and health: those used to make foods or whose use and/or consumption can improve food production or host health; the detection, identification and quantification of those that pose a threat to food safety or quality (also applied to microbial toxins and metabolites and foodborne viruses); the study of their biology (biochemistry, ecology, genetics, physiology...); their role in various food processing methods and in food spoilage; their susceptibility to different physical or chemical agents, processing or packaging methods; or their interaction with different food chain environments and foodstuff, reports on the development and application of mathematical and computational tools in food research. Specific areas of interest were:

- Rapid detection of foodborne pathogens
- High throughput screening
- Norovirus and other viral agents in foods
- Antimicrobial/biocide resistance
- Microbial risk analysis: assessment, management and communication
- Microbiology of fermented foods and beverages
- Food defense

- Food contamination
- Mycotoxins
- Intestinal microbiota and host health
- Hygienic design of food manufacturing lines
- Epidemiology of foodborne pathogens
- Spoilage of soft drinks (with increasing levels of nutrients)
- Biofilms
- Cross-contamination
- Beneficial microbes
- Food parasites
- Microbial nutrition: probiotics
- Bacterial and fungal species: *Yersinia*, *Bacillus*, *Staphylococcus*, *Listeria*, *Salmonella*, *Escherichia coli*, *Vibrio*, *Campylobacter*, *Brucella*, *Mycobacterium*, *Clostridium*, *Streptococcus*, and others; Aflatoxins and other microbial-derived toxins; Norovirus, Rotavirus, Hepatitis virus and other viral agents

Food physics

Topics: understanding and measurement of the physical properties of foods and their constituents: structural, rheological, textural, optical, electrical, thermodynamic, flowing, acoustic, mechanical..., how they change during processing, the relationship between the properties of their constituents (water, proteins, fats, oils, gasses, and minor constituents like vitamins and minerals) and their macroscopic properties (texture, taste, smell, colour, nutritional and health impact), or the developments of purely physical ways of treating foods, either thermal or non-thermal. Specific areas of interest are:

- Thermal modification of foods: heat-moisture treatment, annealing, microwave heating, osmotic pressure treatment ...
- Non-thermal modification of foods: ultrahigh-pressure treatments, instantaneous controlled pressure drop, high-pressure homogenizers, dynamic pulsed pressure, pulsed electric fields, freezing, thawing...
- Multiscale computer simulation and mathematical modeling of food structures
- Novel microscopy, image analysis, and characterization techniques
- Soft matter physics applied to food materials
- Colloidal structures, their interactions and relationship with food stability and overall macroscopic properties
- Modern technologies for sensory analysis
- Relationship between physical properties of food and consumer preferences

Food analysis

Topics: analysis of foods and their constituents (amino acids, peptides, proteins, phenolic compounds, carbohydrates, DNA fragments, vitamins, functional ingredients or nutraceuticals, toxins, pesticide and drug residues, industrial, processing and packaging contaminants, additives, allergens, antibiotics, nanoparticles,...) by the use of analytical and imaging techniques and methods, in the context of the assessment of food structure, quality, safety, traceability, origin, authenticity, health benefits of certain constituents...; works featuring the analysis of large amounts of data generated by different techniques or time series of many variables (chemometrics). Specific areas of interest were:

- Instrumental techniques: biological, separation, spectroscopic, rheological, thermal, radiochemical, electrochemical, miniaturized microfluidic systems, modern foodomics and/or systems biological approaches...
- Imaging techniques: optical, confocal, electron, atomic force microscopies...
- Analysis of sensory properties of foods

- Sample preparation
- Qualitative analysis in a chemometric context
- Data pre-processing
- Calibration standards
- Hyperspectral images
- Image analysis and processing in food science and in industry
- Ingredient distribution in products
- Microstructures of foods: characterization and distribution
- e-noses and e-tongues
- Consumer behaviour

Food processing and packaging

Topics: established and novel processing and packaging technologies applied for delivering foods that last longer before spoiling (preservation), and that are available, safe, nutritious, and convenient, while minimizing environmental impact. Specific areas of interest were:

- Active and intelligent packaging
- Migration and potential health effects of packaging-associated chemicals of concern (Bisphenol-A, semicarbazide...)
- Modified atmosphere packaging
- Established and modern processing and preservation technologies: drying, cooling, freezing, heating, salting, fermentation, pasteurization, additives addition, irradiation, hurdle technology, use of high-pressure and pulsed electric field processing, dense phase carbon dioxide, ozone, ultrasonics, cold plasma, IR technologies, natural antimicrobials, oxygen depleted storage, microwave heating, low shear extrusion...
- Green technologies: supercritical fluid extraction, membrane technology, bioconversions...
- Biorefinery in the production of food components (proteins, carbohydrates, fats...)
- Dietary, health, and environmental concerns related to food processing
- Waste reduction in food processing and valorization of by-products

Food engineering and hygienic design

Topics: (hygienic) design and (safe) operation of food plants, including engineering tools for assessing and managing risks. Specific areas of interest were:

- Heat, mass transfer and fluid flow in food processing
- Artificial intelligence in food research and industry
- Mathematical modelling and software development for food research and industry
- Finding, correcting and preventing hazards in food industry: Hazard Analysis and Critical Control Point (HACCP), Microbial Risk Assessment (MRA)...

Environmental impact of food production and consumption

Topics: environmental impact of the food supply chain (carbon and water footprint, biodiversity, land use...), for each of the food groups. Specific areas of interest were:

- Food waste impact on climate, water, land and biodiversity
- Ways of reducing environmental impact
- Environmental impact of meat production

Foods of plant origin

Topics: plant, animal, crop or soil science relevant to the production of foods of plant origin: cereals, legumes, fruit and vegetables, sugar crops. Specific areas of interest were:

- Understanding phytobiomes for improved crop productivity
- Farming animal science: cattle, sheep, goats, horses, pigs, poultry
- Soil science

- Sustainable farming systems
- Genetic and non-genetic crop improvement
- Plant and crop protection
- Crop models
- Improvement of water use
- Resistance to pests and disease
- Modification of crops for reducing waste
- Filling the gap between plant and crop physiology
- Stress in crops produced by changing environmental conditions

Foods of animal origin

Topics: animal, vegetal, soil or marine/aquatic science relevant in the production of foods of animal origin: meat, fish, milk and their derived products, eggs, insects...

The regular conference program was complemented with two Plenary Lectures:

“Highlighting natural value: physical and chemical approaches in food processing” by Isabel C.F.R. Ferreira, from the Mountain Research Centre (CIMO), ESA, Polytechnic Institute of Bragança, Portugal

“Nonthermal processing technologies for food: Current applications and future perspectives” by Pedro Elez-Martínez, from the University of Lleida, Spain

We hope attendants and readers in general will find the content of this book of abstracts interesting, inspiring and useful and we look forward to seeing you in another fruitful edition of the conference in 2018.

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