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Yanis Caro

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# Emerging greener extraction systems for fungal pigments isolation

Juliana L. D. LEBEAU<sup>1</sup>, Mekala VENKATACHALAM<sup>2</sup>, Mireille FOUILLAUD<sup>2</sup>, Laurent DUFOSSÉ<sup>2</sup> and Yanis CARO<sup>2</sup>

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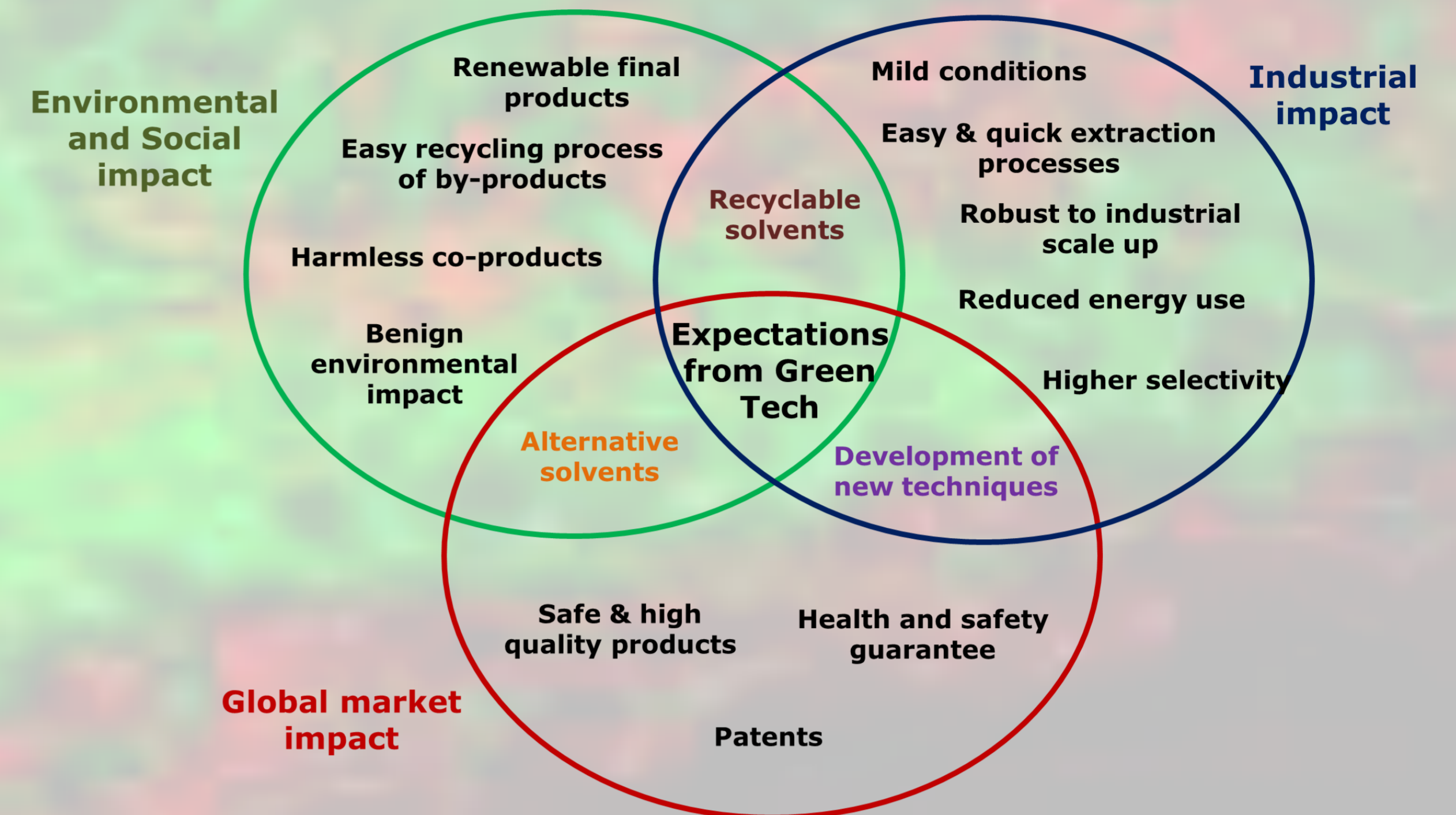
Juliana LEBEAU: [juliana.lebeau@gmail.com](mailto:juliana.lebeau@gmail.com); Mekala VENKATACHALAM: [mekalavenkat@gmail.com](mailto:mekalavenkat@gmail.com)



## Context & Problem:

The demand for natural pigments has been growing over the last two decades and is now becoming a hot topic of research. However, to fully satisfy such demand, there is an urge for the development and design of green and sustainable extraction and isolation techniques that would allow higher recovery and greater selectivity in a quicker and more benign manner than conventional methods. Indeed, the current main extraction methods are still relying on liquid-liquid extraction using organic solvents. These conventional techniques usually involve extended contact with large volumes of solvents or mixture of solvents, high temperatures; They often result in relatively low extraction yield, poor selectivity and in the necessities for further purification steps. Thus, both scale-up and cost-effectiveness of the production of natural pigments at industrial scale are yet limited and require optimisation [1].

Herein, we aim to describe emerging extraction and isolation technologies and methods that would support the development of sustainable and cost-effective production of natural products at industrial scale with a particular focus on fungal pigments for food, cosmetic, pharmaceuticals, and fabrics applications.



## Emerging greener extraction methods:

### Pressurised Fluids Extraction (PFE) and Supercritical Fluid Extraction (SFE):

- Principle:**
  - ⇒ Solvent near or at its critical point by increasing both temperature (about 100°C) and pressure (100-150 bars)
- Advantages:**
  - ⇒ Increase the diversity of solvent (water, CO<sub>2</sub>, methanol,...)
  - ⇒ Enhance extraction capacity and diffusion of the solvent
  - ⇒ Can be used without oxygen (reduced risk of molecule degradation by oxidation)
  - ⇒ Quick and reduced volumes of solvent to be used
- Limits for industrial applications:**
  - ⇒ Cost of using high temperatures and pressures
  - ⇒ Complex apparatus and high initial investment
  - ⇒ Cost of maintenance

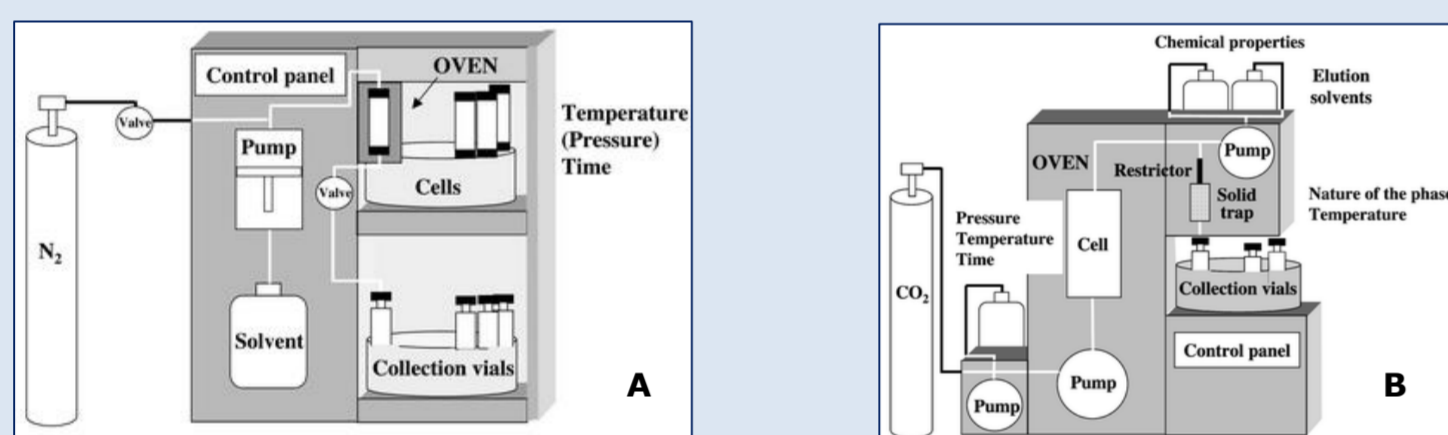


Fig. 1: Schematic description of a Pressurised Fluid Extraction apparatus (A) and a CO<sub>2</sub>-Supercritical Fluid (B) apparatus [2]

### Ionic Liquid-based Aqueous Two-Phase System (IL-ATPS):

- Principle:**
  - ⇒ (IL-ATPS): Use of a water soluble IL, made of a bulky cation (usually imidazolium) with an organic or inorganic anion, and coupled with a salting-out agent (e. g. citrate or sulphate salts) for the extraction of hydrophilic biomolecules

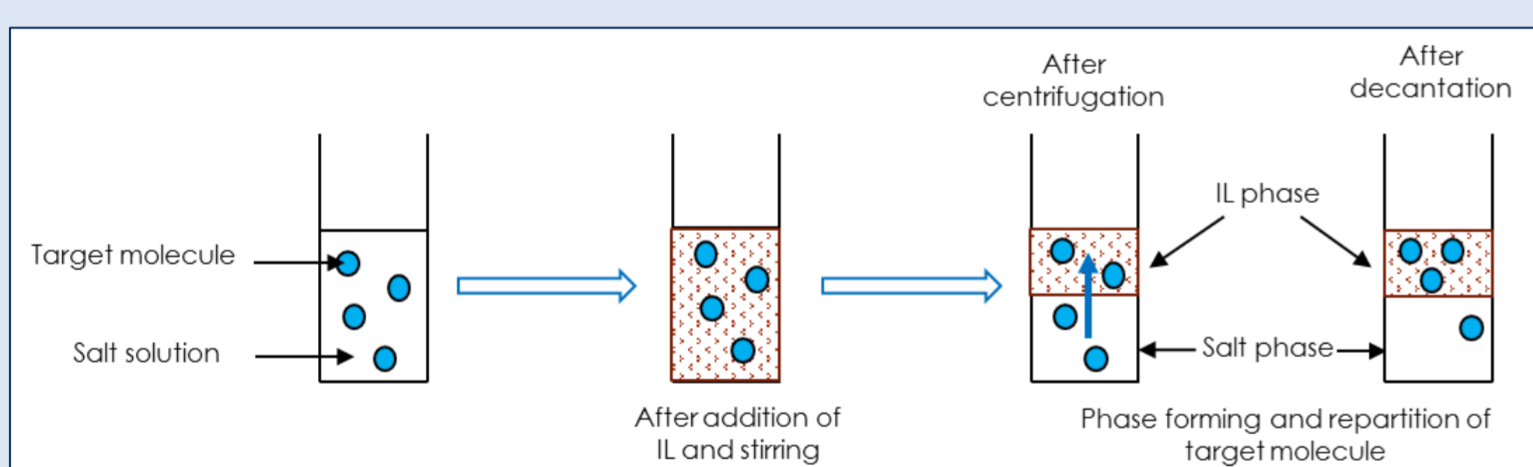


Fig. 2: Schematic description of an IL-based aqueous two-phase system

- ⇒ (IL-microemulsion or IL-based cloud point system): Use of a water insoluble IL (=surfactant) in an aqueous environment to form micelles enhancing extraction of hydrophobic biomolecules. Raising the temperature above a certain limit ( $T_{cloud\ point}$ ) induces a phase separation, forming a micelle-rich phase (top) and an aqueous-rich phase (bottom) [3].

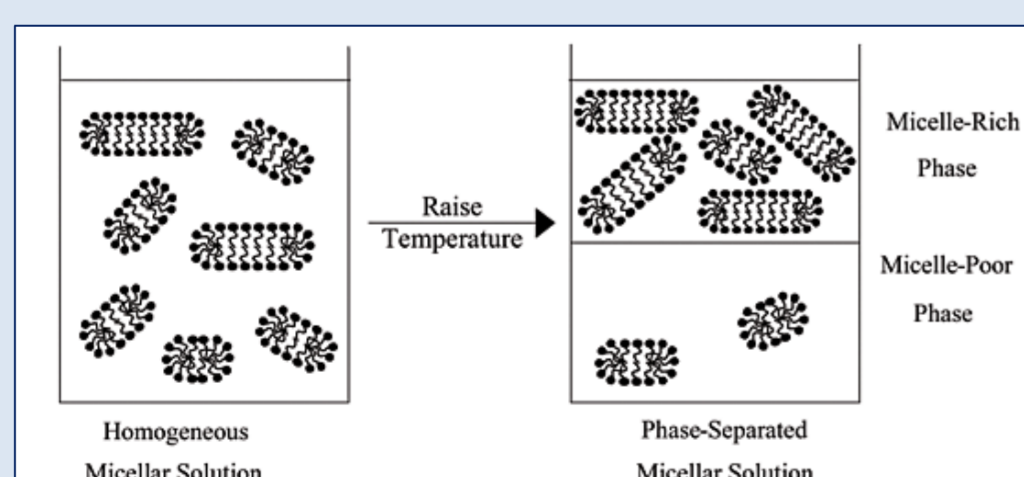


Fig. 3: Schematic description of an IL-based aqueous micellar two-phase system

- Advantages:**
  - ⇒ Tuneable to the molecule to be extracted with high selectivity
  - ⇒ Mild conditions (room temperature)
  - ⇒ High biocompatibility
  - ⇒ Can be associated with other techniques (MAE, US)
  - ⇒ Possibility of recycling the IL
- Limits for industrial applications:**
  - ⇒ Very limited recovery yield of biomolecule from the IL-ATPS
  - ⇒ Cost of IL

### Enzyme Assisted Extraction (EAE):

- Principle:**
  - ⇒ Use of enzymatic specific activity
- Advantages:**
  - ⇒ Increase the plants cell membrane permeability (pectinases, hemicellulases, cellulases) allowing better diffusion of solvent
  - ⇒ Enhance solubility of hydrophobic biomolecules
  - ⇒ Mild conditions (preservation of bioactivities)
  - ⇒ Quick and reduced volumes of solvent to be used
- Limits for industrial applications:**
  - ⇒ Cost of the enzymes and difficulty to recycle them
  - ⇒ Loss of activity over time
  - ⇒ Loss of catalytic efficiency with larger raw material volumes (physical pre-treatment required)



Fungal biomass

PFE/SFE

EAE

MAE

### Microwave Assisted Extraction (MAE):

- Principle:**
  - ⇒ Use of microwave energy (300MHz to 300GHz)
- Advantages:**
  - ⇒ Non-ionizing radiation
  - ⇒ Enhance the partitioning of target molecules from biomass matrix into the solvent
  - ⇒ Quick (5-20min)
- Limits for industrial applications:**
  - ⇒ Water evaporation (may cause unwanted chemical reactions on the target biomolecules)
  - ⇒ Scale-up limited due to heterogeneous heat propagation at bigger scale

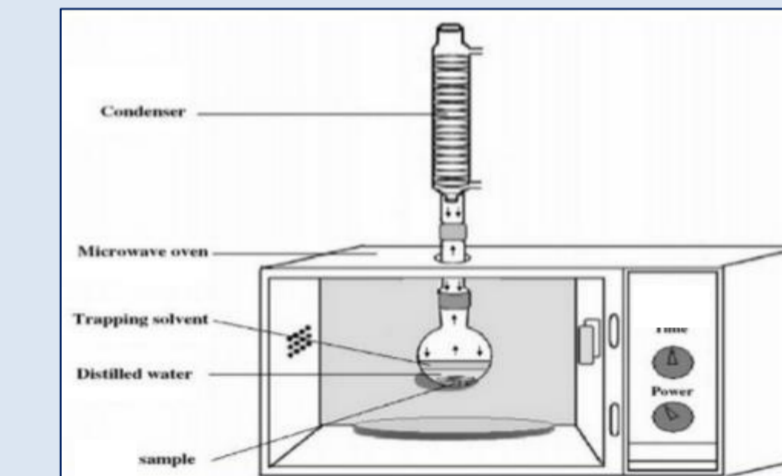


Fig. 4: Schematic description of a microwave assisted extraction apparatus

IL-ATPS

US

IL-ATPS + US

### Ultrasound Assisted Extraction (US):

- Principle:**
  - ⇒ Use of acoustic wave (20 to 2000 KHz)
- Advantages:**
  - ⇒ Straightforward and simple apparatus
  - ⇒ Enhance cavitation due to expansion and compression of air bubbles causing disruption of cell membranes, which allow the release of biomolecules and better solvent diffusion
  - ⇒ Quick and reduced volumes of solvent to be used
- Limits for industrial applications:**
  - ⇒ Heterogeneity of soundwave propagation in heterogeneous system impairing final mass transfer

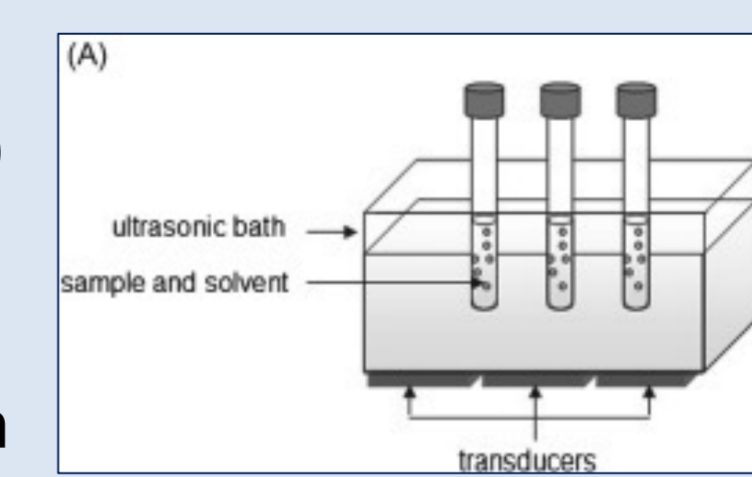
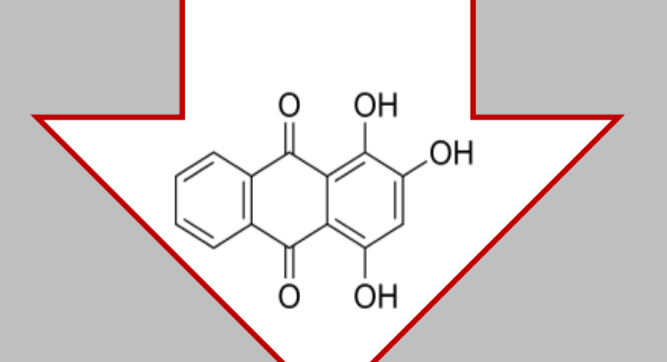


Fig. 5: Schematic description of different types of ultrasound assisted extraction apparatus. A: ultrasonic water bath; B: ultrasound probe.



Pigments for food, pharmaceutical, cosmetic and fabric applications

EXTRACTION

## Conclusion:

New trends of new green extraction technologies have been developed and techniques have been reinvented by performing association with conventional methods in a more sustainable manner. However, the main limitations are the difficulty to scale up at industrial level due to instability of the methods, the price of the extraction materials (solvents, chemicals and apparatus) as well as the cost for maintenance of the process. Once these would be mastered, promising outcomes are expected.

**REFERENCES:** [1] Y. Caro, M. Venkatachalam, J. L. D. Lebeau, M. Fouillaud, and L. Dufossé, *Pigments and colorants from filamentous fungi*, *Fungal Metabolites*, Springer International J.-M. Mérillon, K. G. Ramawar (eds), chapter 26, 2015. [2] V. Camel, *Recent extraction techniques for solid matrices—supercritical fluid extraction, pressurized fluid extraction and microwave-assisted extraction: their potential and pitfalls*, *Analyst*, 126:7, 1182-1193, 2001. [3] C. O. Rangel-Yagui, A. Pessoa-Jr, and D. Blankschtein, *Two-phase aqueous micellar systems—an alternative method for protein purification*, *Brazilian Journal of Chemical Engineering*, 21:4, 531-544, 2004.

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## EMERGING GREENER EXTRACTION SYSTEMS FOR FUNGAL PIGMENTS ISOLATION

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*Keywords: fungal pigments, separation technology, green chemistry, ionic liquids.*

Filamentous fungi produce a mixture of various metabolites such as pigments, fatty acids, proteins and other cellular metabolites. Thus, extraction and isolation of the pigmented molecules of interest are necessary steps before proceeding to any further utilization of these metabolites for commercial applications. Pigments can be stored within the biomass, excreted in the fermentation broth or both, suggesting that extraction methods need to be developed accordingly to the cellular localisation of the pigments and to their chemical natures.

Despite the wide range of separation techniques currently available, most of industrial extraction processes rely on conventional liquid-liquid systems using organic solvent (hexane, dichloromethane, toluene, THF, *etc.*). Since environmental pollution generated by chemical industries has become a central concern in societal and political decisions, there is a growing demand for the development of efficient and *greener* separation technologies. Over the last two decades, and with the emergence of the concept of green chemistry, tremendous progresses have been performed in extraction and separation technologies. Methods such as ultra-sound-assisted extraction, microwave-assisted extraction, pressurised fluid extraction, supercritical fluid extraction, enzyme-assisted extraction, and more recently, ionic liquid assisted extraction were developed. The trend is to create extraction techniques involving cheap and environmental-friendly solvents that can be used under milder conditions with good final efficiency in quicker processes (ideally automatized). From the newest systems, ionic liquids have been recognized as very promising new extraction solvents due to the possibility to tailor their chemical properties and affinities to the target biomolecules.

The focus of this work is to present an overview of the potentialities of the main emerging extraction methods on fungal matrixes for pigments isolation and recovery, with a particular interest for ionic liquids.

**Acknowledgements:**

This work was financed by the University of Reunion Island and the Conseil Régional de La Réunion, COLORMAR project (DIRED / 20140704).



# 8<sup>th</sup> International Congress „Pigments in Food”



Colored Food for Health Benefits

## BOOK of ABSTRACTS

CLAVDIOPOLIS  
COLOSWAR *vulgo* CLAVSENBURG  
*Transilvanie civitas primaria*



**28<sup>th</sup> of June – 1<sup>st</sup> of July 2016**  
**Cluj-Napoca, Romania**





8th International Congress  
„Pigments in Food”  
Colored Food for Health Benefits

**BOOK of ABSTRACTS**

28th of June – 1st of July 2016  
Cluj-Napoca, Romania



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**Pigments in Food- VIII (2016) in Cluj-Napoca, Romania are dedicated to health benefits!**

**PREFACE**

On behalf of the Organizers of the Eight International Congress PIGMENTS IN FOOD, it is our pleasure to welcome you, at the Department of Chemistry and Biochemistry at the University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, Romania.

After seven successful Congresses “Pigments in Food”, starting in Sevilla, Spain (1999) and passing through Lisbon, Portugal (2002), Quimper, France (2004), Stuttgart-Hohenheim, Germany (2006), Helsinki, Finland (2008), Budapest, Hungary (2010), and Novara, Italy (2013), we are honored to host this edition, PIF2016 in the capital of Transylvania region, Romania.

It was the best opportunity for scientists from all over the world (17 countries: UK, USA, Germany, France, Reunion Island, Spain, Italy, Denmark, Hungary, Poland, Turkey, Brazil, Uruguay, Panama, Mexico, China and Romania) to show their advances in scientific and technological topics, related to plant pigments and food colorants.

The 6 sessions were well adapted to cover the most important and outstanding directions of research and technology development in this research e.g. chemical characterization and bioprospecting, to advanced bioanalytical methods, (bio)technological production and formulation, pigment processing and stability, bioactivity, functionality and health effects, as well quality and safety aspects.

The program includes 5 plenary lectures and 7 keynote lectures by best international experts in the field, as well as 20 oral presentations and more than 65 poster contributions. An important aim of PIF2016 is also represented by the opportunity of meeting and discussion for scientists dealing with different aspects of pigments, such as chemists, food chemists, food technologists, biotechnologists, nutritionists, but also industry representatives.

A comprehensive scientific program, adapted to the new approaches and trends in this scientific area was designed and realized – such approach had a particularly strategic aim, to demonstrate that and how pigments and colored food bring health benefits.

We are delighted to offer you, meanwhile, the opportunity to visit the historical city of Cluj-Napoca, to enjoy the traditional food and life in the beautiful Transylvanian landscape and to discover our cultural and academic heritage!

On behalf of the Organizing Committee,

Carmen Socaciu - chair  
Adela Pinteau – co-chair

## SCIENTIFIC PROGRAM - PIF 2016 at USAMV, Cluj-Napoca

Tuesday June 28 <sup>th</sup>	Wednesday, June 29 <sup>th</sup>	Thursday, June 30 <sup>th</sup>	Friday, July 1 <sup>st</sup>
	<p>8.00-9.00 <b>Registration</b></p> <p>9.00-9.45 <b>Plenary lecture 2: Neal Craft</b> 9.45-10.00 Welcome EUCHEMS FCD - Marco Arlorio</p> <p><b>Session 1A</b> <b>Chemical characterization and Bioprospecting</b> 10.00-10.30 Key note lecture 1: Antonio Meléndez Martínez 10.30-11.00 Oral presentations (15min): Jozsef Deli, Mekala Venkatachalam</p> <p><b>11.00-11.30: Coffee Break &amp; Poster session</b></p>	<p><b>Session 4</b> <b>Food processing, pigments stability and color development</b> 8.30-9.15 <b>Plenary lecture 5: Monica Giusti</b> 9.15-9.45 Key note lecture 5: Laurent Dufossé 9.45-11.00 Oral presentations (15 min) Kewei Chen, Mihaela Turturică, Miriana Durante, Pu Jing, Marco Arlorio</p> <p><b>11.00-11.30 Coffee Break &amp; Poster session</b></p>	<p><b>Session 6</b> <b>Quality and safety of food pigments</b> 9.00-9.30 Key note lecture 7: Manfred Eggersdorfer 9.30-10.00 Oral presentations (15min) Michael Murkovic, Antoanela Patras 10.00-10.35 Selected poster presentations (6 x 6 min)</p> <p><b>10.35-11.15 Coffee Break &amp; Poster session</b></p>
<p>14.00-18.00 <b>Registration</b></p> <p>16.30-17.00 <b>Opening Ceremony</b></p> <p>17.00-17.45 <b>Plenary lecture 1: George Britton</b></p> <p>17.45-19.00 <b>Poster session</b></p> <p>19.00 <b>Welcome party</b></p>	<p><b>Session 1B</b> <b>Chemical characterization and Bioprospecting</b> 11.30-12.00 Key note lecture 2: Dámaso H.Méndez 12.00-12.30 Oral presentations (15min) Judith Müller-Maatsch, Işıl İtler</p> <p><b>12.30-13.30 Lunch break</b></p> <p><b>13.30-14.00 Poster session</b> 14.00-14.45 <b>Plenary lecture 3: Øyvind Andersen</b></p> <p><b>Session 2</b> <b>Advanced bioanalytical methods</b> 14.45-15.15 Key note lecture 3: Daniele Giuffrida 15.15-15.45 Oral presentations (15min) A. Ligia Focsan, Luis E. Rodriguez-Saona</p> <p><b>15.45-16.15 Coffee Break &amp; Poster session</b></p> <p><b>16:45-17:30 Plenary lecture 4: Gerhard Sandmann</b></p> <p><b>Session 3 Emerging (bio)technologies of pigment production and formulation</b> 17.30-18.00 Key note lecture 4: Paul Fraser 18.00-18.30 Oral presentations Philippe Thonart, Stefan Martens</p> <p>20.00 <b>Gala Dinner in Cluj-Napoca</b></p>	<p><b>Session 5</b> <b>Bioactivity, functionality and health effects</b> 11.30-12.00 Key note lecture 6: Begoña Olmedilla-Alonso 12.00-13.15 Oral presentations (15 min) Marta Roca, Flore Depeint, Antonio Pérez-Gálvez, Marcello S. Lenucci, Gábor Palotás</p> <p><b>13.15-14.15 Lunch break and Poster session</b></p> <p><b>14.30 Transylvanian Landscape Trip: from Salt Mine Turda to Coltesti, a typical Transylvania village (including Dinner)</b></p>	<p><b>Session 7</b> <b>Round Table</b> 11.15-12.15 Presentation of EU projects: COST EUROCAROTEN FP-7 DISCOvery PROCAR</p> <p>12.15-13.00 <b>Poster Awards and Closing ceremony</b> <b>13.00-14.00 Lunch</b></p> <p><b>Optional social events:</b> City Tour and concerts at International Festival “Jazz in the Park”</p>



## SCIENTIFIC PROGRAMME

### INSTITUTE OF LIFE SCIENCES UNIVERSITY OF AGRICULTURAL SCIENCES AND VETERINARY MEDICINE CLUJ-NAPOCA BLUE HALL

#### 28.06.2016. Tuesday

- 14.00-18.00 Registration  
16.30-17.00 Opening Ceremony  
**Chair: Carmen Socaciu**  
17.00-17.45 **PL1. Reflections from a colour fan.**  
**George Britton**  
*University of Liverpool, School of Biological Sciences, Liverpool L69  
7ZB, U.K.*  
17.45-19.00 Poster session  
19.00-21.00 Welcome party

#### 29.06.2016. Wednesday

- 8.00-9.00 Registration  
**Chair: George Britton - Carmen Socaciu**  
9.00-9.45 **PL2. Chromatography tool box for the separation of pigments.**  
**Neal E. Craft**  
*Craft Technologies, Inc., Wilson, NC USA*  
9.45-10.00 Welcome EUCHEMS FCD  
**Marco Arlorio**  
**Session 1A Chemical characterization and Bioprospecting**  
10.00-10.30 K1. Phytoene and phytofluene in the diet and health.  
**Antonio J. Meléndez-Martínez**  
*Food Colour & Quality Lab., Department of Nutrition & Food Science,  
Universidad de Sevilla Sevilla, Spain*  
10.30-10.45 O1. Carotenoid composition and biosynthesis of  $\beta$ -carotenoids in red  
mamey (*Pouteria Sapota*)  
**József Deli**, Erika Turcsi, Attila Agócs, Veronika Nagy, Gergely Gulyás-  
Fekete, Enrique Murillo.  
*Department of Biochemistry and Medical Chemistry, University of Pécs,  
Hungary*  
10.45-11.00 O2. Isolation and characterization of pigments from *Talaromyces*  
*Albobiverticillius*: a marine derived fungus producing polyketide red  
pigments  
**Mekala Venkatachalam**, Kristian Fog Nielsen, Daniele Giuffrida, Yanis  
Caro, Emmanuelle GirardValenciennes, Laurent Dufossé, Mireille  
Fouillaud  
*Laboratoire de Chimie des Substances Naturelles et des Sciences des  
Aliments – LCSNSA EA 2212, Université de la Réunion, 15 Avenue René  
Cassin, CS 92003, F-97744 Saint-Denis Cedex 9, Ile de la Réunion,  
France*  
11.00-11.30 *Coffee Break & Poster session*

**Session 1B Chemical characterization and Bioprospecting****Chair: Antonia Melendez Martinez – József Deli**

- 11.30-12.00 K2. Xanthophyll esters: the ugly duckling of the carotenoids.  
Dámaso Hornero-Méndez,  
*Department of Food Phytochemistry, Instituto de la Grasa, Consejo Superior de Investigaciones Científicas (CSIC), Sevilla, Spain*
- 12.00-12.15 O3. Characterization and chromoplastidal deposition of carotenoids from gac fruit (*Momordica Cochinchinensis*) arils.  
Judith Mueller-Maatsch, Florence Kreiser, Judith Hempel, Oliver Paquet-Durand, Reinhold Carle, Ralf Schweiggert,  
*University of Hohenheim, Institute of Food Science and Biotechnology, Chair of Plant Foodstuff Technology and Analysis, Garbenstrasse 25, 70599 Stuttgart, Germany*
- 12.15-12.30 O4. Extraction of natural colorant; phycocyanin from cyanobacteria *spirulina platensis*.  
Işıl İlter, Saniye Akyıl, Mehmet Koç, Zeliha Demirel, Meltem Conk-Dalay, Figen Kaymak-Ertekin,  
*Faculty of Engineering, Food Engineering Department, Ege University, Bornova-İZMİR*
- 12.30-13.30 *Lunch*
- 13.30-14.00 Poster session
- 14.00-14.45 **PL3. Anthocyanins in food - facts and challenges.**  
Øyvind M. Andersen  
*Department of Chemistry, University of Bergen, N-5007 Bergen, Norway*
- Session 2 Advanced bioanalytical methods**
- Chair: Paul Fraser - Monica Giusti**
- 14.45-15.15 K3. Application of advanced chromatography methods for the pigments characterization in fresh and overripe fruits and vegetables.  
Daniele Giuffrida, Francesco Cacciola, Margita Utczas, Domenica Mangraviti, Ivana Bonaccorsi, Veronica Inferrera, Paola Donato, Paola Dugo, Luigi Mondello,  
*B.I.O.M.O.R.F. Department, University of Messina, Messina, Italy*
- 15.15-15.30 O5. Carotenoid neutral radicals formed by deprotonation of the radical cation: chemical characterization.  
A. Ligia Focsan, Lowell D. Kispert  
*Department of Chemistry, Valdosta State University, Valdosta, Georgia, United States*
- 15.30-15.45 O6. Authentication of food pigments by vibrational spectroscopy.  
Luis E. Rodriguez-Saona and M. Monica Giusti  
*Department of FoodScience and Technology, The Ohio StateUniversity, Columbus, OH, USA*
- 15.45-16.15 *Coffee Break & Poster session*
- 16:45-17:30 **PL4. Genetic engineering of carotenoid production.**  
Gerhard Sandmann,  
*Molecular Bioscience, Goethe University, Frankfurt/M., Germany*



**Session 3 Emerging (bio)technologies of pigment production and formulation****Chair: Laurent Dufossé – Adela Pinte**

- 17.30-18.00 K4. Genetic intervention approaches to the enhancement of carotenoid and flavonoids in tomato fruit.  
Paul D. Fraser,  
*Biochemistry, School of Biological Sciences, Egham Hill, Egham, Surrey, TW200EX. UK*
- 18.00-18.15 O7. Bioprocessing of anthocyanins extraction from Hibiscus sabdariffa.  
CheikBeye, Thami El Mejdoub, Jacqueline Destain and Philippe Thonart,  
*University of Liege, Gembloux Agro-Bio Tech, Walloon Center for Industrial Biology (CWBI), Passage des Déportés 2, B-5030 Gembloux, Belgium*
- 18.15-18.30 O8. From bench to application: ANTHOPLUS – anthocyanin production platform using advanced plant suspension cultures as green cell factories (ERA-IB).  
Stefan Martens, Cathie Martin, Ingo Appelhagen, Trine Hvoslef-Eide, Anne Oertel, Doris Marko, Gudrun Pahlke, Hans-Peter Mock, Andrea Matros,  
*TransMIT Project Division for Plant Metabolites and Chemicals, Germany*
- 20.00-23.00 *Gala Dinner – Restaurant Da Vinci*

**30.06.2016. Thursday****Session 4****Food processing, pigments stability and color development****Chair: B. Olmedilla Alonso - Marco Arlorio**

- 8.30-9.15 **PL5. Anthocyanin chemical structure affects their stability, bioavailability and functionality in the human body**  
Monica Giusti  
*Food Science and Technology department, The Ohio State University*
- 9.15-9.45 K5. Red colorants from filamentous fungi. Are they ready for the food industry?  
Laurent Dufossé  
*Université de La Réunion, LCSNSA Laboratoire de Chimie des Substances Naturelles et des Sciences des Aliments & ESIROI agroalimentaire, F-97490 Saint-Denis, Reunion island, Indian ocean, France*
- 9.45-10.00 O9. Chlorophyll catabolites present in the main edible seaweed species.  
Kewei Chen, Jose Julián Ríos, Antonio Pérez-Gálvez, María Roca,  
*Department of Food Phytochemistry, Instituto de la Grasa, Consejo Superior de Investigaciones Científicas (CSIC), Sevilla, Spain*
- 10.00-10.15 O10. Characterisation and thermal degradation of anthocyanins from red plums.  
Mihaela Turturică, Nicoleta Stănciuc, Gabriela Bahrim, Gabriela Râpeanu,  
*Dunărea de Jos University of Galati, Faculty of Food Science and Engineering, 111 Domnească Street, 800201, Galati, Romania*
- 10.15-10.30 O11. Encapsulation in cyclodextrins of pumpkin and tomato oleoresins extracted by supercritical CO<sub>2</sub>.  
Miriana Durante, Marcello Salvatore Lenucci, Pier Paolo Marrese, Vito Rizzi, Monica De Caroli, Gabriella Piro, Paola Fini, Giovanni Mita,  
*Istituto di Scienze delle Produzioni Alimentari, Consiglio Nazionale delle Ricerche (CNR), Lecce, Italy*

- 10.30-10.45 O12. Computer simulation and experimental methods to study influence of three phenolic acids on peonidin derivative stability.  
Manman Lu, Jianxiong Cai, Wei Xu, Jing Chen, Shujuan Zhao, Pu Jing  
*Department of Food Science and Engineering, Shanghai Jiao Tong University, Shanghai*
- 10.45-11.00 O13. Formation of coloured diaminobenzoquinones from (ethyl)vanillin in bakery products.  
M. Arlorio, R. Negri, G. del Favero, J.D. Coisson, V. Papillo, F. Travaglia, V. Gokmen, D. Marko, G.B. Giovenzana.  
*Dipartimento di Scienze del Farmaco & Drug and Food Biotechnology Center, Università del Piemonte Orientale A. Avogadro, 28100 Novara, Italy*
- 11.00-11.30 *Coffee Break & Poster session*
- Session 5**  
**Bioactivity, functionality and health effects**  
**Chair: Øyvind Andresen - Damaso Hornero-Mendez**
- 11.30-12.00 K6. Bioavailability, bioaccessibility and bioconversion of the major provitamin A carotenoids in the human diet.  
Begoña Olmedilla-Alonso,  
*Institute of Food Science, Technology and Nutrition (ICTAN-CSIC), Madrid, Spain*
- 12.00-12.15 O14. Bioavailability of chlorophyll derivatives in human epithelial cells.  
Kewei Chen, María Roca,  
*Department of Food Phytochemistry, Instituto de la Grasa, CSIC, Sevilla, Spain*
- 12.15-12.30 O15. Hypolipemic activity of astaxanthin supplementation in mice.  
Myriam Benarroch, Justine Lallement, Larbi Rhazi, Camille Boroch, Cindy Hugot, Claude-Narcisse Niamba, Hassan Younes, Flore Depeint,  
*Department of Nutrition and Health Sciences, LaSalle Beauvais Polytechnic Institute, Beauvais, France*
- 12.30-12.45 O16. Human colostrum is a pool of carotenoid metabolites. A systematic approach with MS tools.  
Antonio Pérez-Gálvez, Juan Garrido-Fernández, José J. Ríos, Adriana Mercadante, Ana A.O. Xavier, Josefa Aguayo Maldonado,  
*Food Phytochemistry Department, Instituto de la Grasa (CSIC), Sevilla, Spain*
- 12.45-13.00 O17. Health turns red: comparative study on supercritical CO<sub>2</sub> extraction of lycopene from fruits and effect of the nanocarrier encapsulated oleoresins on cultured lung adenocarcinoma cells.  
Andreina Bruno, Mirana Durante, Elisabetta Pace, Pier Paolo Marrese, Giovanni Mita, Gabriella Piro, Marcello S. Lenucci,  
*Dipartimento di Scienze e Tecnologie Biologiche ed Ambientali (Di.S.Te.B.A.), Università del Salento, Lecce, Italy*
- 13.00-13.15 O18. Development and human clinical study of a new vegetable puree product.  
Gábor Palotás, Eszter Sarkadi Nagy, Hussein Daood, Éva Martos, Lajos Helyes, Andrea Lugasi,  
*Univer Product Zrt., Kecskemét, Hungary*



- 13.15-14.15 *Lunch break and Poster session*  
14.30-22.00 *Transylvanian Landscape Trip: from Salt Mine Turda to Colțesti, a typical Transylvanian village (including Dinner)*

**01.07.2016. Friday**

**Session 6**

**Quality and safety of food pigments**

**Chair: Philippe Thonart - Gerhard Sandmann**

- 9.00-9.30 K7. Perspectives in innovation in food pigments – An industry view.  
Manfred Eggersdorfer, Ulrich Killeit, Dirk Cremer,  
*DSM Nutritional Products, Kaiseraugst, Switzerland*
- 9.30-9.45 O19. Oxidation of edible oils in presence of carotenes and xanthophylls.  
Michael Murkovic, Alam Zeb, Marini Damanik,  
*Graz University of Technology, Institute of Biochemistry, Functional Food Group, Petersgasse 12/2, 8010 Graz, Austria*
- 9.45-10.00 O20. Colour evaluation and antioxidant activity of red cabbage extract in presence of different additives.  
Antoanela Patras, Razvan Filimon.  
*Department of Sciences, Faculty of Horticulture, University of Agricultural Sciences and Veterinary Medicine „Ion Ionescu de la Brad”, Iasi, Romania*
- 10.00-10.35 Selected poster presentations
- 10.35-11.15 *Coffee Break & Poster session*

**Session 7**

**Round Table**

- 11.15-12.15 Presentation of EU projects: COST EUROCAROTEN, FP-7 DISCOvery and PROCAR  
O21. From DISCOvery to products: A next generation pipeline for the sustainable generation of high-value plant products  
The DISCO consortium (coordinator Paul D. Fraser)  
*Biochemistry, School of Biological Sciences, Royal Holloway University of London, Egham Hill, Egham, Surrey, TW20 OEX. UK*  
O22. Cost action EUROCAROTEN (European network to advance carotenoid research and applications in agro-food and health, CA15136)  
Antonio J. Meléndez-Martínez  
*Food Colour & Quality Lab., Department of Nutrition & Food Science, Universidad de Sevilla, Seville, Spain.*  
O23. PROCAR: the exploitation of *Xanthophyllomyces Dendrorhous* as a sustainable platform for the production of high-value carotenoids, an ERA-IB-14-073 project.  
Gerhard Sandmann,  
*Biosynthesis Group, Molecular Biosciences, Goethe University Frankfurt, Frankfurt, Germany*
- 12.15-13.00 Poster Awards and Closing ceremony
- 13.00-14.00 *Lunch*

## List of Posters

## Session 1 Chemical characterization and Bioprospecting

1

- P1-1 Far UV peak contributes to the identification of E/Z isomers of carotenoids.  
Enrique Murillo,  
*Laboratorio de Bioquímica de Alimentos y Nutrición, Universidad de Panamá, Panamá, Panamá*
- P1-2 Isolation of allene carotenoids from mamey.  
Attila Agócs, Enrique Murillo, Erika Turcsi, Szabolcs Béni, András Darcsi, József Deli  
*Department of Biochemistry and Medical Chemistry, University of Pécs, Hungary*
- P1-3 Evaluation of bioactive compounds in fermented black table olives.  
Miriana Durante, Maria Tufariello, Luca Tommasi, Gianluca Bleve, Giovanni Mita  
*Istituto di Scienze delle Produzioni Alimentari, Consiglio Nazionale delle Ricerche (CNR), Lecce, Italy*
- P1-4 Anthocyanins composition of jaboticaba and pitanga from different cities of Brazil  
Anna Rafaela Braga, Katia Biazotto, Veridiana Vera de Rosso,  
*Biosciences Department, Federal University of São Paulo, Santos - São Paulo, Brazil*
- P1-5 Carotenoid composition of four Brazilian fruits from Atlantic forest and cerrado.  
Kátia Regina Biazotto, Anna Rafaela Cavalcante Braga, Veridiana Vera de Rosso,  
*Biosciences Department, Federal University of São Paulo, Santos - São Paulo, Brazil*
- P1-6 Black as a tomato: the anthocyanin-synthesizing tomato genotype 'Sun Black<sup>TM</sup>'  
F. Blando, H. Berland, M. Durante, C. Gerardi, A. Mazzucato, G. Mita, Ø M Andersen  
*Institute of Sciences of Food Production - Lecce section Italian National Research Council (CNR), Lecce- Italy*
- P1-7 Reduction of decarboxylated derivatives of betacyanin pigments.  
Dominika Szot, Sławomir Wybraniec,  
*Department of Analytical Chemistry, Institute C-1, Faculty of Chemical Engineering and Technology, Cracow University of Technology, Cracow, Poland*
- P1-8 Oxidation of hydrogenated derivatives of betanin.  
Dominika Szot, Sławomir Wybraniec,  
*Department of Analytical Chemistry, Institute C-1, Faculty of Chemical Engineering and Technology, Cracow University of Technology, Cracow, Poland*
- P1-9 Anthocyanin-rich extract from Italian black rice (*Var. Artemide*) as functional ingredient for bakery products.  
Monica Locatelli, Valentina Azzurra Papillo, Fabiano Travaglia, Jean Daniel Coïsson and Marco Arlorio  
*Dipartimento di Scienze del Farmaco & Drug and Food Biotechnology Center, Università degli Studi del Piemonte Orientale, Novara, Italy*

- P1-10 Application of progressive pearling process to anthocyanins rich wheat cultivars to obtain pigmented ingredients.  
Monica Locatelli, Valentina A. Papillo, Stefania Monteduro, Fabiano Travaglia, Debora Giordano, Amedeo Reyneri, Massimo Blandino, Marco Arlorio, Jean Daniel Coisson,  
*Dipartimento di Scienze del Farmaco, Università del Piemonte Orientale “A. Avogadro”, Novara, Italy*
- P1-11 Carotenoid glycoside isolated and identified from cyanobacterium *Cylindrospermopsis raciborskii*.  
Veronika Nagy, Attila Agócs, József Deli, Gergely Gulyás-Fekete, Tünde-Zita Illyés, Erika Turcsi, Gábor Vasas,  
*Department of Biochemistry and Medical Chemistry, University of Pécs, Pécs, Hungary*
- P1-12 Extraction of fungal polyketide pigments using ionic liquids.  
Juliana Lebeau, Mekala Venkatachalam, Mireille Fouillaud, Laurent Dufossé and Yanis Caro,  
*University of La Réunion, LCSNSA & ESIROI Saint-Denis, Reunion Island, Indian ocean, France*
- P1-13 Marine-derived fungi producing red anthraquinones: new resources for natural colors?  
Mireille Fouillaud, Mekala Venkatachalam, Yanis Caro, and Laurent Dufossé,  
*Laboratoire de Chimie des Substances Naturelles et des Sciences des Aliments – LCSNSA EA2212, Université de la Réunion, Saint-Denis, Ile de la Réunion, France*
- P1-14 Distribution and evolution of phenolic compounds in skins and seeds of different grape varieties.  
Elisabeta-Irina Geană, Alexandru Ciocârlan,  
*National R&D Institute for Cryogenics and Isotopic Technologies – ICIT Rm. Valcea, 4th Uzinei Street, PO Raureni, Box 7, 240050 Rm. Valcea, Romania*
- P1-15 Phenolic profile and antioxidant properties of functional foods based on honey and dry fruits.  
Elisabeta-Irina Geană, Cornelia Dostetan,  
*National R&D Institute for Cryogenics and Isotopic Technologies – ICIT Rm. Valcea, 4th Uzinei Street, PO Raureni, Box 7, 240050 Rm. Valcea, Romania*
- P1-16 Optimization of fermentation conditions for fungal growth and production of red pigments from *Talaromyces albobiverticillius* using response surface methodology.  
Mekala Venkatachalam, Alain Shum Cheong Sing, Yanis Caro, Laurent Dufossé, Mireille Fouillaud,  
*Laboratoire de Chimie des Substances Naturelles et des Sciences des Aliments – LCSNSA EA 2212, Université de la Réunion, 15 Avenue René Cassin, CS 92003, F-97744 Saint-Denis Cedex 9, Ile de la Réunion, France*
- P1-17 Bacterial carotenoid production of antarctic isolates.  
María Eugenia Vila, Gastón Azziz, Silvia Batista, Verónica Saravia,  
*Bioengineering Department, Chemical Engineering Institute, Engineering Faculty, Universidad de la República, Montevideo, Uruguay.*
- P1-18 Potential of chromosomes 7D and 7D<sup>ch</sup> for the enhancement of lutein esterification in wheat.  
Maria G. Mattera, Adoración Cabrera, Dámaso Hornero-Méndez, Sergio G. Atienza,  
*Department of Food Phytochemistry, Instituto de la Grasa (CSIC), Campus Universidad Pablo de Olavide, Edificio 46, Ctra. de Utrera, Km 1, E-41013 Sevilla, Spain*



- P1-19 Identification and quantification of anthocyanins in wild berries by HPLC-PDA-ESI-MS.  
Zorița Diaconeasa, Dumitrița Rugină, Loredana F. Leopold, Andrea Bunea, Andreea Stănilă, Carmen Socaciu,  
*Department of Food Science and Technology, University of Agricultural Sciences and Veterinary Medicine, Cluj-Napoca, Romania*

**Session 2 Advanced bioanalytical methods**

**2**

- P2-1 Structural characterization of chlorophyll derivatives.  
 Antonio Perez-Gálvez, K. Chen, José Julián Ríos, María Roca,  
*Department of Food Phytochemistry, Instituto de la Grasa, CSIC, Sevilla, Spain*
- P2-2 Separation of mamey (*Pouteria sapota*) carotenoid epoxide diastereomers on chiral stationary phase.  
Erika Turcsi, Tibor Kurtán, Enrique Murillo, Veronika Nagy, József Deli,  
*Department of Biochemistry and Medical Chemistry, University of Pécs, Pécs, Hungary*
- P2-3 A solid-phase extraction method for reducing matrix effect on the MS<sup>n</sup> analysis of xanthophyll esters.  
Ana A.O. Xavier, Juan Garrido-Fernández, José J. Ríos, Antonio Pérez-Gálvez,  
*Laboratório de Química de Alimentos, DCA - FEA – UNICAMP Campinas, São Paulo - Brasil*
- P2-4 Thin layer chromatography (TLC) separation combined with RAMAN mapping for carotenoid identification.  
Loredana Florina Leopold, Cristina Coman, Zorita Diaconeasa, Nicolae Leopold, Carmen Socaciu,  
*Faculty of Food Science and Technology, University of Agricultural Sciences and Veterinary Medicine, Mănăştur 3-5, 400372 Cluj-Napoca, Romania*
- P2-5 Raman imaging of norbixin after cellular internalization in D407 RPE cells.  
Cristina Coman, Loredana Florina Leopold, Olivia Dumitrița Rugină, Zorița Diaconeasa, Oana Lelia Pop, Maria Tofană, Carmen Socaciu, Adela Pinte, Nicolae Leopold,  
*Faculty of Food Science and Technology, University of Agricultural Sciences and Veterinary Medicine, Cluj-Napoca, Romania*

**Session 3 Emerging (bio)technologies of pigment production and formulation**

**3**

- P3-1 Emerging greener extraction systems for fungal pigments isolation.  
Juliana Lebeau, Mekala Venkatachalam, Mireille Fouillaud, Laurent Dufossé and Yanis Caro,  
University of Reunion Island, LCSNSA & ESIROI, Saint-Denis, Reunion Island, Indian ocean, France.
- P3-2 Identification of chlorophyll profile in *Phormidium utumnale* biomass.  
Leila Queiroz Zepka, Gabriela P. Nogara, Andressa S. Fernandes, Daniele B. Rodrigues, Adriana Z. Mercadante, Eduardo Jacob-Lopes,  
*Department of Food Technology and Science, University Federal of Santa, Santa Maria, Brazil*
- P3-3 The bioeconomy of carotenoid-rich oleoresins produced in microalgal biorefineries.  
Eduardo Jacob-Lopes, Tatiele Casagrande do Nascimento, Leila Queiroz Zepka,  
*Department of Food Technology and Science, Federal University of Santa Maria, Brazil*

- P3-4 Carotenoid profile and antioxidant capacity of three microalgae species.  
Eduardo Jacob-Lopes, Tatiele Casagrande do Nascimento, Luciana Dapieve Patias, Andressa Fernandes, Leila Queiroz Zepka,  
*Department of Technology and Food Science, Federal University of Santa Maria-RS, Brazil*
- P3-5 Bioconversion of anthocyanins from jussara pulp by *Lactobacillus* and *Bifidobacterium*.  
Anna Rafaela Braga, Veridiana Vera de Rosso,  
*Biosciences Department, Federal University of São Paulo, Santos - São Paulo, Brazil*
- P3-6 New and sustainable carotenoid extraction from tomatoes for food industry.  
Paula Martins, Veridiana de Rosso,  
*Departamento Bioscience, Federal University of São Paulo, Baixada Santista, Brazil*
- P3-7 Carotenoid-rich microspheres and microcapsules: comparative efficiency of encapsulation, stability and delivery *in vitro* (simulated gastric and intestinal media).  
F. Romanciuc, A. Lazar, F. Csernaton, C. Socaciu,  
*University of Agricultural Sciences and Veterinary Medicine  
RTD Centre for Applied Biotechnology, Proplanta SRL*
- P3-8 Zeaxanthin production by *Antarctic Flavobacterium* Sp..  
María Eugenia Vila, Alejandra Rodriguez, Verónica Saravia,  
*Bioengineering Department, Chemical Engineering Institute, Engineering Faculty, Universidad de la República, Montevideo, Uruguay*
- P3-9 A metabolite profiling approach to the characterisation of new colour mutants in *Xanthophyllomyces dendrorhous*.  
Eugenio Alcalde, Thunazzina Ali and Paul D Fraser,  
*School of Biological Science, Royal Holloway University of London, Egham, TW20 0EX, UK*
- P3-10 Phenolic compounds, flavonoids, carotenoids and antioxidant capacity of apricot (*Prunus armeniaca* L.) pomace fermented by two filamentous fungi in solid state system.  
Francisc V. Dulf, Dan C. Vodnar, Andrea Bunea, Adela Pinte, Carmen Socaciu,  
*Department of Environmental and Plant Protection, University of Agricultural Sciences and Veterinary*
- P3-11 Microwave effect on free and encapsulated, with or without sea buckthorn, *Lactobacillus casei* ATCC 393 in yoghurt.  
Oana Lelia Pop, Francisc Dulf, Lucian Cuiabus, Dan Cristian Vodnar, Cristina Coman, Carmen Socaciu, Ramona Suharoschi,  
*Department of Food Science, University of Agricultural Science and Veterinary Medicine Cluj-Napoca, Romania*
- P3-12 Carotenoid production by *Blaskelea trispora* on crude glycerol media.  
Vodnar Dan Cristian, Francisc Vasile Dulf, Alexandru Rusu, Trif Monica, Pop Oana Lelia, Socaci Sonia, Carmen Socaciu,  
*Department of Food Science and Technology, University of Agricultural Sciences and Veterinary Medicine, Cluj-Napoca, Romania*

#### **Session 4 Food processing, pigments stability and color development**

- P4-1 Evaluation of color stability of the non-genotoxic purple pigment from *Peltogyne mexicana* heartwood as a colorant for yoghurt and gelatin products.  
Paulina Gutiérrez, Cinthya Gutiérrez, Leticia Garduño, Myriam Arriaga,  
Blanca Barragán,  
*Department of Environmental Systems Engineering, Instituto Politécnico Nacional, México City, Mexico*

- P4-2 Stability of betalain from *Stenocereus pruinosus* fruit as a yellow-orange colorant for gummies and model beverages.  
Juan A. Rodríguez-Sánchez, Blanca E. Barragán-Huerta,  
*Department of Environmental Systems Engineering, Escuela Nacional de Ciencias Biológicas, Instituto Politécnico Nacional, Av. Wilfrido Massieu, Unidad Profesional Adolfo López Mateos, D.F. 07738, Mexico*
- P4-3 Influence of olive fruit stones on changes and transfer of chlorophyll pigments during virgin olive oil elaboration.  
Honorio Vergara-Domínguez, María Roca and Beatriz Gandul-Rojas,  
*Chemistry and Biochemistry Pigment Group, Food Phytochemistry Department, Instituto de la Grasa (CSIC), Sevilla, Spain*
- P4-4 Changes and transfer of chlorophyll pigments during virgin olive oil elaboration from heat-treated fruits.  
Honorio Vergara-Domínguez, María Roca and Beatriz Gandul-Rojas B.  
*Chemistry and Biochemistry Pigment Group, Food Phytochemistry Department, Instituto de la Grasa (CSIC), Sevilla, Spain*
- P4-5 Pigment changes during preservation of green table olive specialities treated with alkali and without fermentation: effect of thermal treatments and storage conditions.  
Beatriz Gandul-Rojas, Lourdes Gallardo-Guerrero,  
*Chemistry and Biochemistry Pigment Group, Food Phytochemistry Department, Instituto de la Grasa (CSIC), Sevilla, Spain*
- P4-6 Development of carrots with high pigmentation for natural food colors.  
Sabine Karin Clausen, Søren Kjærsgaard Rasmussen,  
*University of Copenhagen, Faculty of Science, Department of Plant and Environmental Sciences, Section for Plant and Soil Science, Molecular Plant Breeding Group, Thorvaldsensvej 40, 1871 Frederiksberg C, Denmark*
- P4-7 Anthocyanin and phenolic profile of red wines obtained from Karalahna grapes, a native grape variety of Bozcaada (Tenedos), Turkey  
Burcu Şişli, Nesrin Merve Çelebi, Aslı Bayhan, Ayşegül Kırca Toklucu,  
*Department of Food Engineering, Faculty of Engineering, Çanakkale Onsekiz Mart University, Çanakkale, Turkey*
- P4-8 Effect of spontaneous and inoculated fermentations on anthocyanins and phenolics of Cabernet Sauvignon wines.  
Nesrin Merve Çelebi, Burcu Şişli, Aslı Bayhan, Ayşegül Kırca Toklucu,  
*Department of Food Engineering, Faculty of Engineering, Çanakkale Onsekiz Mart University, Çanakkale, Turkey*
- P4-9 The effect of physical form of *Phaeodactylum tricornutum* biomass on fucoxanthin extraction.  
Saniye Akyıl, Işıl İlter, Mehmet Koç, Zeliha Demirel, Ayşegül Şeker- Erdoğan, Meltem Conk- Dalay, Figen Kaymak-Ertekin,  
*Food Engineering Department, Faculty of Engineering, Ege University, Bornova-IZMIR- TURKEY*
- P4-10 Juice processing effects on quality of aronia pomace—a resource for colour extraction.  
Michael Vagiri and Martin Jensen,  
*Department of Food Science, Aarhus University, Kirstinebjergvej 10, DK-5792, Årslev, Denmark*
- P4-11 Spectral and colorimetric characteristics of metal chelates of acylated cyanidin derivatives.  
Gregory T. Sigurdson, Rebecca Robbins, Thomas Collins, M. Mónica Giusti  
*The Ohio State University, Dept. of Food Science and Technology, 2015 Fyffe Ct., Columbus, OH 43210-1007, United States*



- P4-12 The influence of copigmentation, pH and ionic force on the antioxidant activity and colour parameters of chokeberry (*Aronia melanocarpa*) extract.  
Elena Cristea, Rodica Sturza, Marius Niculaua, Aliona Ghendov-Moşanu, Antoanela Patras,  
*Department of Sciences, Faculty of Horticulture, University of Agricultural Sciences and Veterinary Medicine „Ion Ionescu de la Brad”, Iasi, Romania*
- P4-13 Anthocyanins thermal degradation in sour cherry extract on fluorescence spectroscopy and kinetic modeling basis.  
Ana Maria Oancea, Florentina Mihaela Ursache, Gabriela Râpeanu and Nicoleta Stănciuc,  
*Dunărea de Jos University of Galati, Faculty of Food Science and Engineering, Domnească Street 111, 800201, Galati, Romania*
- P4-14 Thermal degradation of the total carotenoid content and antioxidant activity of sea buckthorn (*Hippophae rhamnoides L.*)– A kinetic study.  
Florentina Mihaela Ursache, Ana Maria Oancea, Gabriela Râpeanu and Nicoleta Stănciuc,  
*Dunărea de Jos University of Galati, Faculty of Food Science and Engineering, Domnească Street 111, 800201, Galati, Romania*
- P4-15 Thermal degradation kinetics of anthocyanins extracted from anthocyanins extracted from sweet cherries.  
Mihaela Turturică, Nicoleta Stănciuc, Gabriela Bahrim, Gabriela Râpeanu, Dunărea de Jos University of Galati, Faculty of Food Science and Engineering, 111 Domnească Street, 800201, Galati, Romania
- P4-16 Identification and quantification of carotenoids presents in Brazilian peppers compared to other varieties.  
José Fernando Rinaldi Alvarenga, Paola Andressa Schurachio, Maria Terezinha Silva Bonifácio, Célia Maria Sylos,  
*Department of Food Science and Nutrition, School of Pharmaceutical Science, UNESP, Araraquara, SP, Brazil*
- P4-17 Lipophilic antioxidant capacity, color proprieties and carotenoid content of peppers cultivated in Brazil.  
José Fernando Rinaldi Alvarenga, Paola Schurachio, Maria Terezinha Silva Bonifácio, Célia Maria Sylos,  
*Department of Food Science and Nutrition, School of Pharmaceutical Science, UNESP, Araraquara, SP, Brazil*
- P4-18 Stability of carotenoids in frozen and dried sea buckthorn (*Hippophae Rhamnoides L.*) berries.  
Elena Andreea Pop, Andrea Bunea, Adela Pinteau,  
*Department of Chemistry and Biochemistry, University of Agricultural Sciences and Veterinary Medicine, Cluj-Napoca, Romania*
- P4-19 The variation of chlorophylls, carotenoids and antioxidant activity in fresh, frozen and dried aromatic plants.  
Sanda Andrei, Andrea Bunea, Constantin Bele, Adela Pinteau,  
*Department of Biochemistry, University of Agricultural Sciences and Veterinary Medicine, Cluj-Napoca, Romania*

## Session **Bioactivity, functionality and health effects**

### 5

- P5-1 New approach for pigment metabolomics studies.  
María Roca, José Julián Ríos, Antonio Pérez-Gálvez,  
*Department of Food Phytochemistry, Instituto de la Grasa, CSIC, Sevilla, Spain.*

- P5-2 Intervention with different doses of oleaginous extracts of *Tagetes* or kale: effects on lutein content in plasma, lipophilic antioxidant capacity and macular pigment optical density.  
Carina Holzwarth, Lara Schubert, Kai Wildner, Volker Böhm,  
*Institute of Nutrition, Friedrich Schiller University Jena, Jena, Germany*
- P5-3 Identification of main dietary sources of polyphenols and assessment of consumption frequency of polyphenol-rich foods and beverages in a typical sample of Romanian adult population.  
Iris-Lisbeth Müller, Elena Rakosy-Tican,  
*Doctoral School of Integrative Biology, Babeş-Bolyai University, Cluj-Napoca, Romania*
- P5-4 Chemistry of fungi in chemistry classes of lower and upper secondary level.  
Farina Bunjes, Martin Rühl, Verena Pietzner, Holger Zorn, Peter Fleischmann,  
*Chemistry Education, Institute of Chemistry, Oldenburg University, Oldenburg, Germany*
- P5-5 Pigments in blueberries (*Vaccinium myrtilloides* L.) and sea buckthorn (*Hippophae rhamnoides* L.) used in the treatment of diabetes.  
Dana Pusta, Roman Morar, Alexandra Pusta,  
*Department of Animal Productions and Food Safety, Faculty of Veterinary Medicine, University of Agricultural Sciences and Veterinary Medicine, Cluj-Napoca, Romania*
- P5-6 Technological strategies for the use of watermelon as a source of bioactive molecules and antioxidant pigments.  
Marcello S. Lenucci, Stefania Grassi, Pier Paolo Marrese, Anna Montefusco,  
*Dipartimento di Scienze e Tecnologie Biologiche ed Ambientali (Di.S.Te.B.A.), Università del Salento, Lecce, Italy*
- P5-7 Green vegetables may not be the most important determinant of macular pigment optical density: a study of food source and colour in Spanish subjects.  
Rocío Estévez-Santiago, Begoña Olmedilla-Alonso, Beatriz Beltrán-de-Miguel, Carmen Cuadrado-Vives,  
*Institute of Food Science, Technology and Nutrition (ICTAN-CSIC), Madrid (Spain)*
- P5-8 Lupines as model for teaching sustainable food production.  
Jutta Honkomp, Michael Schott, Peter Eisner, Verena Pietzner,  
*Chemistry Education, Institute of Chemistry, Oldenburg University, Oldenburg, Germany*
- P5-9 Bioaccessibility of phytoene and phytofluene from fruit and vegetable juices as compared to other carotenoids.  
Paula Mapelli-Brahm, Joana Corte-Real, Antonio J. Meléndez-Martínez,  
Torsten Bohn,  
*Food Colour & Quality Lab., Dpt. of Nutrition & Food Science, Universidad de Sevilla, Seville, Spain*
- P5-10 Elderberry-derived anthocyanins induce apoptosis and inhibit cell proliferation in melanoma cells.  
Rugină Dumitrița, Hanganu Dana, Diaconeasa Zorița, Coman Cristina, Leopold Loredana, Bunea Andrea, Pinteada Adela,  
*Faculty of Veterinary Medicine, University of Agricultural Sciences and Veterinary Medicine, Cluj-Napoca, Romania*

**Session Quality and safety of food pigments**

**6**

- P6-1 Infogest *in vitro* digestion method adapted to carotenoids.  
Daniele B. Rodrigues, Lilian R. B. Mariutti, Ana Augusta O. Xavier, Adriana Z. Mercadante,  
*Department of Food Science, University of Campinas, São Paulo, Brazil*
- P6-2 Marigold: much more than lutein esters.  
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Agócs Attila .....	16, 41, 50	Cremer Dirk .....	14
Akyıl Saniye.....	19, 84	Cristea Elena.....	87
Alcalde Eugenio.....	72	Csertatoni F.....	70
Ali Thunazzina.....	72	Cuadrado-Vives Carmen.....	101
Andersen Øyvind M.....	4, 45	Cuibus Lucian.....	74
Andrei Sanda.....	94	Damanik Marini.....	34
Appelhagen Ingo.....	23	Daood Hussein.....	33
Arlorio Marco.....	28, 48, 49	Darcsi András.....	41
Arriaga Myriam.....	76	De Caroli Monica.....	26, 100
Atienza Sergio G.....	57	De Rosso Veridiana Vera .....	43, 44, 68, 69
Azziz Gastón.....	56	Del Favero G.....	28
Bahrim Gabriela.....	25, 90	Deli József.....	16, 41, 50, 60
Barragán Blanca.....	76	Demirel Zeliha.....	19, 84
Batista Silvia.....	56	Depeint Flore.....	30
Bayhan Aslı.....	82, 83	Destain Jacqueline.....	22
Bele Constantin.....	94	Diaconeasa Zorita.....	58, 62, 63, 104
Beltrán-de-Miguel Beatriz.....	101	Donato Paola.....	10
Benarroch Myriam.....	30	Dostetan Cornelia.....	54
Béni Szabolcs.....	41	<b>Dufossé Laurent.....</b>	<b>12, 17, 51, 52, 55, 64</b>
Berland H.....	45	Dugo Paola.....	10
Beye Cheik.....	22	Dulf Francisc Vasile.....	73, 74, 75
Blandino Massimo.....	49	Durante Miriana.....	45, 32, 26, 42, 100
Blando F.....	45	Eggersdorfer Manfred.....	14
Bleve Gianluca.....	42	Eisner Peter.....	102
Böhm Volker.....	96	El Mejdoub Thami.....	22
Bohn Torsten.....	103	Estévez-Santiago Rocío.....	101
Bonaccorsi Ivana.....	10	Filimon Razvan.....	35
Boroch Camille.....	30	Fini Paola.....	26
Britton George.....	2	Fleischmann Peter.....	98
Bruno Andreina.....	32	Focsan A. Ligia.....	20
Bunea Andrea.....	58, 73, 93, 94, 104	Fog Nielsen Kristian.....	17
Bunjes Farina.....	98	Fouillaud Mireille.....	17, 51, 52, 55, 64
Cabrera Adoración.....	57	Fraser Paul D.....	11, 36, 38, 72
Cacciola Francesco.....	10	Gallardo-Guerrero Lourdes.....	80
Cai Jianxiang.....	27	Gandul-Rojas Beatriz.....	78, 79, 80
Carle Reinhold.....	18	Garduño Leticia.....	76
Caro Yanis.....	17, 51, 52, 55, 64	Garrido-Fernández Juan.....	31, 61
Cavalcante Braga Anna Rafaela.....	43, 44, 68	Geană Elisabeta-Irina.....	53, 54
Chen Jing.....	27	Gerardi C.....	45
Chen Kewei.....	24, 29, 59	Ghendov-Moşanu Aliona.....	87
Cheong Sing Alain Shum.....	55	Giordano Debora.....	49
Ciocârlan Alexandru.....	53	Girard-Valenciennes Emmanuelle.....	17
Clausen Sabine Karin.....	81	Giuffrida Daniele.....	10, 17
Coisson J.D.....	28	Giusti M. Mónica.....	6, 21, 86
Coisson Jean Daniel.....	48, 49	Gokmen V.....	28
Collins Thomas.....	86	Grassi Stefania.....	100
Coman Cristina.....	62, 63, 74, 104	Gulyás-Fekete Gergely.....	16, 50
Conk-Dalay Meltem.....	19, 84	Gutiérrez Cinthya.....	76
Corte-Real Joana.....	103	Gutiérrez Paulina.....	76
Craft Neal E.....	3	Hanganu Dana.....	104

Helyes Lajos.....	33	Müller Iris-Lisbeth.....	97
Hempel Judith.....	18	Murillo Enrique.....	16, 40, 41, 60
Holzwarth Carina.....	96	Murkovic Michael.....	34
Honkomp Jutta.....	102	Nagy Eszter Sarkadi.....	33
Hornero-Méndez Dámaso.....	9, 57	Nagy Veronika.....	16, 50, 60
Hugot Cindy.....	30	Negri R.....	28
Hvoslef-Eide Trine.....	23	Niamba Claude-Narcisse.....	30
Illyés Tünde-Zita.....	50	Niculau Marius.....	87
İlter Işıl.....	19, 84	Oancea Ana Maria.....	88, 89
Inferrera Veronica.....	10	Oertel Anne.....	23
Jensen Martin.....	85	Olmedilla-Alonso Begoña.....	13, 101
Jing Pu.....	27	Pace Elisabetta.....	32
Kaymak-Ertekin Figen.....	19, 84	Pahlke Gudrun.....	23
Killeit Ulrich.....	14	Palotás Gábor.....	33
Kispert Lowell D.....	20	Papillo A. Valentina.....	48, 49
Koç Mehmet.....	19, 84	Papillo V.....	28
Kreiser Florence.....	18	Paquet-Durand Oliver.....	18
Kurtán Tibor.....	60	Patras Antoanela.....	35, 87
Lallement Justine.....	30	Pérez-Gálvez Antonio...24, 31, 59, 61, 95	
Lazar A.....	70	Pietzner Verena.....	98, 102
Lebeau Juliana.....	51, 64	Pintea Adela.....	63, 73, 93, 94, 104
Lenucci Marcello Salvatore...26, 32, 100		Piro Gabriella.....	26, 32, 100
Leopold Loredana Florina..58, 62, 63,104		Pop Elena Andreea.....	93
Leopold Nicolae.....	62, 63	Pop Oana Lelia.....	63, 74, 75
Locatelli Monica.....	48, 49	Pusta Alexandra.....	99
Lu Manman.....	27	Pusta Dana.....	99
Lugasi Andrea.....	33	Rakosy-Tican Elena.....	97
Maldonado Josefa Aguayo.....	31	Râpeanu Gabriela.....	25, 88, 89, 90
Mangraviti Domenica.....	10	Rasmussen Søren Kjærsgaard.....	81
Mapelli-Brahm Paula.....	103	Regina Biazotto Katia.....	43, 44
Mariutti Lilian R. B.....	105, 106	Reyneri Amedeo.....	49
Marko D.....	28	Rhazi Larbi.....	30
Marko Doris.....	23	Rinaldi Alvarenga José Fernando...91, 92	
Marrese Pier Paolo.....	26, 32, 100	Ríos Jose Julián.....	24, 31, 59, 61, 95
Martens Stefan.....	23	Rizzi Vito.....	26
Martin Cathie.....	23	Robbins Rebecca.....	86
Martins Paula.....	69	Roca María.....	24, 29, 59, 78, 79, 95
Martos Éva.....	33	Rodrigues Daniele B.....	105, 106
Matros Andrea.....	23	Rodriguez Alejandra.....	71
Mattera Maria G.....	57	Rodríguez-Sánchez Juan A.....	77
Mazzucato A.....	45	Rodriguez-Saona Luis E.....	21
Meléndez-Martínez Antonio J. .8, 37, 103		Romanciuc F.....	70
Mercadante Adriana Z.....	31, 105, 106	Rugină Dumitrița.....	58, 63, 104
Merve Çelebi Nesrin.....	82, 83	Rühl Martin.....	98
Mita G.....	32, 45	Rusu Alexandru.....	75
Mita Giovanni.....	26, 42, 32, 100	Sandmann Gerhard.....	5, 38
Mock Hans-Peter.....	23	Saravia Verónica.....	56, 71
Mondello Luigi.....	10	Schott Michael.....	102
Monteduro Stefania.....	49	Schubert Lara.....	96
Montefusco Anna.....	100	Schurachio Paola Andressa.....	91
Morar Roman.....	99	Schurachio Paola.....	92
Mueller-Maatsch Judith.....	18	Schweiggert Ralf.....	18

Sigurdson Gregory T.....	86
Silva Bonifácio Maria Terezinha ....	91, 92
Şişli Burcu.....	82, 83
Socaci Sonia.....	75
Socaciu Carmen	58, 62, 63, 70, 73,74, 75
Stănciuc Nicoleta .....	25, 88, 89, 90
Stănilă Andreea .....	58
Sturza Rodica .....	87
Suharoschi Ramona .....	74
Sylos Célia Maria.....	91, 92
Szot Dominika .....	46, 47
Thonart Philippe.....	22
Tofană Maria.....	63
Toklucu Ayşegül Kirca .....	82, 83
Tommasi Luca .....	42
Travaglia Fabiano .....	28, 48, 49
Trif Monica .....	75
Tufariello Maria .....	42
Turcsi Erika.....	16, 41, 50, 60
Turturică Mihaela.....	25, 90
Ursache Florentina Mihaela .....	88, 89
Utczas Margita .....	10
Vagiri Michael .....	85
Vasas Gábor.....	50
Venkatachalam Mekala	17, 51, 52, 55, 64
Vergara-Domínguez Honorio .....	78, 79
Vila María Eugenia .....	56, 71
Vodnar Dan Cristian .....	73, 74, 75
Wildner Kai.....	96
Wybraniec Sławomir .....	46, 47
Xavier Ana A.O. ....	31, 61, 105
Xu Wei .....	27
Younes Hassan.....	30
Zeb Alam .....	34
Zhao Shujuan .....	27
Zorn Holger.....	98

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