Program and Book of Abstracts

Innovation and advanced technologies for managing postharvest pathogens

VI International Symposium on Post-harvest Pathology

29 May - 02 June 2022

Limassol, Cyprus

The **VI International Symposium on Post-harvest Pathology**: Innovation and advanced technologies for managing postharvest pathogens organized under the aegis of the International Society for Horticultural Science (ISHS) and the International Society for Plant Pathology (ISPP).

The symposium is taking place for the first time in Cyprus, in Limassol/Lemesos from the **Cyprus University of Technology** (Cyprus), Department of Agricultural Sciences, Biotechnology & Food Science, from May 29 2022 until June 2nd 2022.

Table of Contents

Message from the Symposium Convener
-3-
Welcome messages from ISHS and ISPP
-4-
Committees
-7-
Invited Speakers
-8-
Symposium Program
-14-
Abstract Index
-25-
Plenary Lectures
-35-
Oral Presentations
-45-
Poster Presentations
-85-
Author Index
-150-
Sponsors
-155-

Welcome message from the convener

Dear Colleagues,

IT is my great honor to organize the VI International Symposium on Postharvest Pathology. I want to warmly welcome you on this event and hopefully having the opportunity to host you in Cyprus, to experience our friendship and hospitality, to appreciate the island's natural beauties and taste local cuisine and wine, after the unfortunate period of the last 2 years with the pandemic.

The most important reason for your visit though is to attend the VI International Symposium on Postharvest Pathology. I promise you that the Symposium will be thought-provoking, will provide new information regarding plant pathology and novel and advanced technologies for managing postharvest pathogens. The growing world population, the ever increasing extended supply chains and the irreversible rate of urbanization and climate change are driving a focus towards the innovation of new means postharvest management of fruits, vegetables, herbs and flowers.

My hope is that this meeting will further enrich our disciplines, and contribute towards the mentoring of the next generation of young scientists.

Here in Cyprus, we tried our best, during these hard times, with this symposium, with any available way, to provide to you all the benefits that a physical meeting has, after a long hiatus. Prominent invited speakers, a multi discipline series of sessions, networking opportunities, round tables, discussion sessions and connection with industry.

I would like to take this opportunity to thank all the participants for their support and their participation.

I am wishing you a fruitful and exciting symposium.

Sincerely,

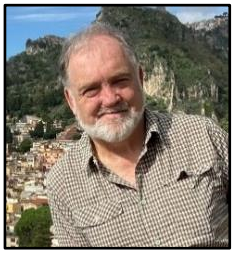
Dr. Nikolaos Tzortzakis, convener
Cyprus University of Technology

Welcome message from the ISHS

AS Chair of the Division of Postharvest and Quality Assurance of the ISHS, I am delighted to be part of the VI International Symposium on Post-harvest Pathology in beautiful Limassol, Cyprus.

The theme of this meeting – Innovation and advanced technologies for manging postharvest pathogens – reflects the importance of a research endeavor that is critical to reducing food loss in an ever populating world.

Gathered together over these few days are scientists from universities, research institutes and industry, postdocs, graduate students and others. Many of you here are renewing old friendships built over many years, while for others this is your first international meeting. As you enjoy the formal science – the oral and poster presentations – I encourage you to also ensure that you mix and mingle during the breaks and less formal opportunities. I still remember my first international meeting and the impact of the warm welcome from the 'big names' in the field. So, if you are a well-known postharvest pathologist, please introduce yourselves to the new students and budding profressionals who will be the future leaders in the field. And, if you are a new student or budding profressional do not be shy – make sure you reach out and introduce yourself. You are part of a wonderful discipline that is carrying out research for the world.



Prof. Chris Watkins
Chair, Quality and Postharvest Horticulture Commission, ISHS

Welcome message from the ISHS

AS chair of the ISHS Workgroup Postharvest Pathology, it is a real pleasure to welcome all of you to the VI International Symposium on Postharvest Pathology (ISPP).

Like each ISPP, the Symposium will address the questions related to postharvest supply chain management, and this will include all the process from pathology detection, prevention and protection till processing and distribution in an attempt to satisfy consumer demands. It will be a forum to bring researchers, academics and industry professionals to share knowledge and research contribution in the evolving technologies related postharvest pathology.

Today our planet is facing great challenges. Global environmental, social and economic challenges drive the need for new and improved solutions for food production and consumption. This includes the postharvest domain which must carry on its evolution in a sustainable way. Both fundamental and applied sciences are always at the heart of our Symposium. However, this VI ISPP must be an opportunity for stakeholders to highlight specific challenges linked to a sustainable development of our sector and to address these challenges in a near future.

Besides the science, our convener, Nikolaos Tzortzakis, will organize several social events. They are used to strengthen and develop collaborations. It is also the opportunity to enjoy time with our colleagues.

I'm pursued that your active contribution will make this event successful both at scientific and social level.

Prof. Haissam Jijakli
Chair, Workgroup Postharvest Pathology, ISHS

Welcome message from the ISPP

Dear Participants,

I would like to personally welcome you to the VI International Symposium on Postharvest Pathology held in Limassol, Cyprus, while the world is still trying to recover from the COVID-19 pandemic and facing the war in Europe and its consequences on the food supply chain.
It is indeed challenging times for the postharvest scientific community and other stakeholders to maintain the supply of safe fresh fruits and vegetables while adopting cost-effective and sustainable technologies for reducing losses due to microbial pathogens. We are confronting a time of many changes in regulations in many countries around the world and the continuous demand for high-quality safe food products that are free of toxic chemicals. Our meeting has always been an event where students, young and established scientists, as well as industry colleagues meet together and present cutting-edge basic and applied research in postharvest pathology as well as discussing the strategies to translate research results into practical commercial applications.
I wish you all a very fruitful symposium and hope that you will use the next few days to meet new people, share ideas and discuss future collaborations. Special thanks to the convener, Prof. Nikolaos Tzortzakis and members the local and international organizing committees for their endless efforts and hard work to bring to all of us a high-quality scientific program and for making our stay in Limassol as enjoyable as possible.

Yours faithfully,

Prof. Samir Droby
Chair, Postharvest Pathology SMC, ISPP

Organizing Committee

Nikolaos Tzortzakis, *Cyprus University of Technology, Limassol, Cyprus*
Antonios Chrysargyris, *Cyprus University of Technology, Limassol, Cyprus*
Panayiota Xylia, *Cyprus University of Technology, Limassol, Cyprus*
Carmit Ziv, *Volcani Center, Agricultural Research Organization (ARO), Israel*
Geoffroy de Chabot-Tramecourt, *Janssen PMP, Janssen Pharmaceutica NV, Belgium*

Scientific Committee

Antonio Ippolito, *University of Bari, Italy*
Antonios Chrysargyris, *Cyprus University of Technology, Cyprus*
Chris Watkins, *Cornell University, Ithaca, NY, U.S.A.*
Davide Spadaro, *University of Turin, Italy*
Gianfranco Romanazzi, *Marche Polytechnic University, Italy*
Jijakli Haissam, *University of Liège, Belgium*
Kerry Everett, *New Zealand Institute for Plant & Food Research, New Zealand*
Leonardo Schena, *Mediterranean University of Reggio Calabria, Italy*
Lise Korsten, *University of Pretoria, South Africa*
Lluis Palou, *Valencian Institute of Agrarian Research (IVIA), Spain*
Luis González-Candelas, *Institute of Agrochemistry & Food Technology (IATA), Spain*
Maria Teresa Lafuente, *Institute of Agrochemistry & Food Technology (IATA), Spain*
Michael Wisniewski, *US Depart. of Agriculture, Agricultural USDA-ARS, USA*
Neus Teixido, *Research Inst. of Technology, Food & Agriculture (IRTA), Spain*
Noam Alkan, *Volcani Center, Agricultural Research Organization (ARO), Israel*
Samir Droby, *Volcani Center, Agricultural Research Organization (ARO), Israel*
Shiping Tian, *Institute of Botany, The Chinese Academy of Sciences, China*

INVITED SPEAKERS

Pauline Voorbraak

Pauline Voorbraak, MBA, is Global Product Manager Postharvest at Janssen Preservation and Material Protection (PMP), a division of Janssen Pharmaceutica N.V. (Group Johnson & Johnson). Since 2019, she is responsible for the product management of the global postharvest product portfolio. With more than 15 years of sales and managerial experience in an international environment, which she gained through a variety of roles in different working environments. Next to this she has developed expertise and knowledge of projects of business development, strategic collaborations, and expansion strategies. She started her career as one of the managers of the family-owned company active in crop protection for more than 8 years. She assumed roles in business, marketing, and development as well as production and operational planning. In 2012, she founded her independent consultancy firm and was active as consultant providing management advice in crop protection and biocides including biostimulants and green molecules.

Davide Spadaro

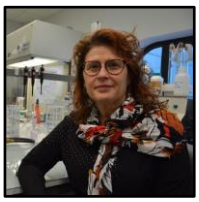
Associate Professor at University of Torino (Italy) and Researcher at AGROINNOVA on pre- and post-harvest diseases of fruit crops, on mycotoxins and mycotoxigenic fungi, and on molecular diagnostics. He is visiting professor at Thammasat University, University of Edinburgh, University of Lleida, and University of Bonn. He is secretary of SMC Postharvest of International Society of Plant Pathology and a member of the Academy of Agriculture of Torino. He has also coordinated and worked on several European and national projects, publishes more than 118 peer-reviewed journal articles with around 3000 citations and H-index 30 on Scopus.

Samir Droby

Prof. Samir Droby is a senior research scientist at the ARO, the Volcani Center, and a Professor of Plant Pathology and postharvest Sciences, The Hebrew University of Jerusalem. Samir has extensive research expertise in developing biological and naturally-based control strategies for pre and postharvest diseases, studying the mode of action of yeast biocontrol agents, pathogenicity mechanisms of Penicillium species on citrus and apple fruit, resistance mechanisms of fruits against postharvest pathogens and characterization of fruit microbiome and its manipulation for beneficial effects against postharvest pathogens. He pioneered the exploration and the development of commercial biological control products (e.g. 'Noli' and 'Aspire') that are based on naturally occurring yeasts. In recent years, he has been exploring the possibility of using microbial consortia for biocontrol. Prof. Droby published more than 150 articles in peer-reviewed journals, 23 review articles, and 25 book chapters on various topics on postharvest pathology.

Haïssam Jijakli

Professor and Responsible of Integrated and Urban Plant Pathology Laboratory (Liège University), Haïssam Jijakli is managing a team of 25 persons, leading 15 research's. During the last 30 years, he developed biocontrol methods based on (micro)-organisms and their derivatives to protect plants against phytopathogens. Since the beginning of his career, he participated or coordinated in Belgium and abroad more than 60 programs, dealing with the successive steps of development of biological control (selection; formulation; mechanisms of action; IPM; monitoring tools and ecology; practical trials). He has to his credit more than 400 scientific outputs (including more than 130 refereed articles and 7 patents) and created 4 spin off companies, one being involved in the development of a biopesticide based on a yeast against postharvest diseases of fruits. That yeast, *Candida oleophila* strain O is now registered at EU and US level under the name of NEXY. Another recent spin off is under development and will be dedicated to the bioherbicides based on essential oils.

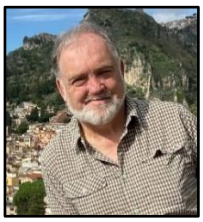


Neus Teixidó

Dr. Neus Teixidó received her BSc and the PhD in Agronomist Engineer from the University of Lleida. She is a senior research scientist and the head of Postharvest Department at IRTA (Research Institute of Technology, Food and Agriculture), Catalonia, Spain. She is also the coordinator of Fruit.Net, the Plant Health National Program to optimize the use of pesticides and reduce the residues of fruits in Catalonia. Her research activity includes the control of postharvest diseases of fruits (mainly pome, citrus, stone fruits and grapes) using several physical, chemical and biological alternative techniques, the study of epidemiology, and fruit-pathogen interactions in different pathosystems. She has over 20 years of experience in the development of biocontrol agents (production, formulation, stabilization, improvement in front stress conditions and efficacy). She has participated or coordinate more than 60 national and international projects, published more than 130 peer-reviewed journal articles, more than 60 technical papers, 16 books or books chapters and deposited 4 patents.

Antonio Ippolito

Full professor in Plant Pathology and coordinator of the PhD course in “Biodiversity, Agriculture and Environment”. His scientific activity is documented by more than 400 publications regarding various aspects of Plant Pathology in Mediterranean crops. In particular, he studied aetiology, epidemiology, chemical, and biological control of fungal diseases of fruits, canopy, and roots. For over 30 years he is carrying out research on the use of alternative control means against postharvest decay of fresh fruits and vegetables by means of physical, biological, natural substances, and organic and inorganic salts. By using molecular techniques, he conducted studies on diagnosis and quantification of several phytopathogenic microorganisms. More recently, he deals with the study on mechanisms of resistance in the host induced by various elicitors. In 2015 he has been convener of the “III International Symposium on Postharvest Pathology”, Bari June 7-11. He has been Chair of the international Workgroup “Biological Control of Postharvest Diseases” and is member of the international Commissions “Quality and Postharvest Horticulture” and “Plant Protection” of the International Society for Horticultural Science.



Chris Watkins

Prof. Watkins is Associate Dean in the College of Agriculture and Life Sciences (CALS) and Director in Cornell Cooperative Extension (CCE) at Cornell University, Ithaca, New York. Chris carries out a research program on storage and ripening of fruits and vegetables from both applied and fundamental aspects. His primary interests are in understanding the underlying mechanisms of apple fruit responses to postharvest technologies in relation to preharvest factors. He has published over 175 peer reviewed papers, 18 book chapters, 44 conference proceedings, and 126 trade, newsletter and technical articles. Chris has graduated 9 MS and 12 PhDs students, and in addition has hosted many visiting scholars. He was elected Fellow of the American Society for Horticultural Sciences in 2015, CALS Outstanding Faculty award in 2018, and Fellow of the International Society for Horticultural Sciences in 2021. He is also Chair of the International Society for Horticultural Science Division for Postharvest Physiology and Quality Assurance, as well as Editor-in Chief of the journal, Postharvest Biology and Technology.

Gianfranco Romanazzi

Prof. Romanazzi received his degree ‘cum laude’ in Agricultural Sciences in 1995 and PhD in Crop Protection in 1999 at the University of Bari. He joined Marche Polytechnic University in Ancona in 2001, where he chairs BSc in Agricultural Science and Technology and MSc in Land and Agricultural Technology. Since June 2020 he is President of the Italian Association for Plant Protection (Associazione Italiana per la Protezione delle Piante, AIPP). He has experience in the application of strategies to manage postharvest decay of fresh fruit and vegetables and reduce food waste through alternatives to synthetic fungicides, with particular focus on induced resistance.

Lise Korsten

Prof. Korsten is the co-Director of the Department of Science and Innovation / National Research Foundation Centre of Excellence Food Security. She is a full-time professor in plant pathology. Prof Korsten has focused her research mainly on complementary fields of postharvest technology and food safety as related to international trade in fresh produce. As a team her group has been able to develop several innovative technologies to reduce disease and prevent product contamination. More recently her research programme has focused on food systems in the informal market and fresh produce traded on the local markets. Prof Korsten has published more than 200 international peer reviewed papers and books/ chapters. She has supervised 51 MSc students, 20 PhD students and 11 Post Docs. Prof Korsten developed South Africa's first biocontrol agent for fruit and established a biocontrol research group at the University of Pretoria. She is an editor for Food Security, Springer and Chair of the International Society for Plant Pathology Task Force on Global Food Security.

Symposium Program

15:00-18:30	**Attendee Registration** *Attaching posters on the board (Poster Session I: No 1-32)*
19:00-20:30	Welcome reception/ welcoming participants **(LAB Cafe/Restaurant)**

08:00-09:00 **Attendee Registration**
Attaching posters on the board (Poster Session I: No 1-32)

09:00-09:30 **Welcome Ceremony and Opening Remarks**
Nikolaos Tzortzakis-Convener- Welcoming
CUT /local authorities' representatives- Welcoming
Haïssam Jijakli/Chris Watkins-Welcoming & ISHS presentation
Samir Droby -ISPP Welcoming and starting

09:30-10:45 **Session I. Management of postharvest diseases – Industry perspective**
Moderators: Antonio Ippolito, Samir Droby

Plenary lecture

PL1 **09:30-10:00** **Global postharvest industry, the paradox between the scientific community, the industry and the consumers**
Pauline Voorbraak, Janssen Pharmaceutica NV, Belgium

Oral Presentations

OP1 **10:00-10:15** **High efficacy postharvest plant-based green treatments for citrus decay control**
Javier Parra, Productos Citrosol, Spain

Round table discussion section

10:15-10:45 **Industry perspective and consumer demand – quality vs. safety**
Moderator: Geoffroy de Chabot-Tramecourt
Panel: Geoffroy de Chabot-Tramecourt, Javier Parra, Petr Rubak, Clara Montesinos, Andreas Agrotis

10:45-11:15 Coffee break

11:15-13:00 **Session II. Detection and monitoring of postharvest pathogens and their toxic metabolites**
Moderators: Davide Spadaro, Kerry Everett

Plenary lecture

PL2 **11:15-11:45** **Advanced diagnostics tools to detect and study the epidemiology of postharvest pathogens**
Davide Spadaro, University of Torino. Italy

Oral Presentations

OP2 **11:45-12:00** **Inoculum release and other factors influencing infection of apples by *Neofabraea vagabunda* (Bull's eye rot)**
Kerry Everett, The New Zealand Institute for Plant and Food Research Limited, New Zealand

OP3 **12:00-12:15** **Incidence of postharvest diseases of carrot with special focus on tip rot**
Belachew Asalf, Norwegian Institute of Bioeconomy, Norway

OP4 **12:15-12:30** **Comparative genomics of the brown rot fungi *Monilinia fructicola*, *M. laxa* and *M. fructigena***
Lucia Landi, Marche Polytechnic University, Italy

OP5 **12:30-12:45** ***Aspergillus carbonarius* lacking veA or pks genes involved in the OTA mycotoxin biosynthesis outcompete the parental strain during both *in vitro* and *in vivo* growth**
Ana-Rosa Ballester, Institute of Agrochemistry and Food Technology (IATA-CSIC), Spain

OP6	**12:45-13:00**	**Preliminary epidemiological features of kiwifruit skin pitting agent: *Cadophora luteo-olivacea* (J.F.H. Beyma) T.C. Harr. & McNew)** *Alessandra Di Francesco, University of Bologna, Italy*
	13:00-14:00	Lunch break
Poster Session I (Start: No 1-32) *Business meeting*		
	14:00-14:30	*Poster Session I*
	14:30-16:15	**Session II (continues). Detection and monitoring of postharvest pathogens and their toxic metabolites** *Moderators: George Karaoglanidis, Antonios Chrysargyris*
Oral Presentations		
OP7	**14:30-14:45**	**Strains of *Penicilium expansum* exhibiting Multidrug Resistance phenotype show an overexpression pattern of efflux transporter genes and genes of patulin biosynthesis pathway** *George Karaoglanidis, Aristotle University of Thessaloniki, Greece*
OP8	**14:45-15:00**	**Unravelling the impact of conventional and organic farming system on Black Aspergilli population structure, mycotoxigenic capacity and mycotoxin contamination assessment in Greek wines, using a new Q-TOF MS-MS detection method** *Stefanos Testempasis, Aristotle University of Thessaloniki, Greece*
OP9	**15:00-15:15**	***Alternaria* spp. causing postharvest decay on apple fruit in Nigde province, Turkey** *Keziban Sinem Tulukoglu Kunt, Nigde Omer Halisdemir University, Turkey*
Flash poster presentation		
	15:15-16:15	Flash poster presentation (20 e-posters * 3 min each) *Moderator: Antonios Chrysargyris*
	16:15-16:45	Coffee break
	16:45-18:30	**Session III. Interactions of postharvest pathogens with the host and its microbiome** *Moderators: Lise Korsten, Noam Alkan*
Plenary lecture		
PL3	**16:45-17:15**	**The mechanisms of assembly and dynamics of the microbiome on fruit surfaces – a new understanding of postharvest diseases and their management** *Samir Droby, The Volcani Institute, ARO, Israel*
Oral Presentations		
OP10	**17:15-17:30**	**Glycosylated flavonoids: fruit's concealed antifungal arsenal** *Noam Alkan, The Volcani Institute, ARO, Israel*
OP11	**17:30-17:45**	**Fungal microbiome shifts of avocado fruit from flowering to the ready-to-eat stage** *Malick Bill, University of Pretoria, South Africa*
OP12	**17:45-18:00**	**Impact of storage technologies on epiphytic blemishes of apple fruit** *Angelo Zanella, Research Centre Laimburg, Italy*

OP13	**18:00-18:15**	**Identification of *Monilinia fructicola* effectors that contribute to peach leaf infection** *Laura Vilanova Torren, Institute of Agrifood Research and Technology (IRTA), Spain*
	19:30-22:30	**Dinner**

	08:00-09:00	**Attendee Registration** *Attaching posters on the board (Poster Session I: No 1-32)*
	08:45-09:00	**Opening Remarks** *Nikolaos Tzortzakis-Convener*
	09:00-10:45	**Session IV. Innovative and Sustainable technologies to manage postharvest pathogens** *Moderators: Haïssam Jijakli, Leonardo Schena*
Plenary lecture		
PL4	**09:00-09:30**	**30 years of biocontrol of postharvest fruit diseases with *Pichia anomala* strain K: Factors affecting efficacy and reliability, including microbiome interactions** *Haïssam Jijakli, University of Liège, Belgium*
Oral Presentations		
OP14	**09:30-09:45**	**Natamycin, a new natural compound for postharvest: Opportunities and challenges** *Geoffroy de Chabot-Tramecourt, Janssen Pharmaceutica NV, Belgium*
OP15	**09:45-10:00**	**Phenylalanine: A new inducer improve fruit quality and resistance to postharvest pathogens and chilling injury** *Manish Kumar Patel, The Volcani Institute, ARO, Israel*
OP16	**10:00-10:15**	**Nano-clay particles loaded with double-strand RNA reduces *Botrytis cinerea* colonization and gray-mold in harvested fruits** *Danielle Duanis-Assaf, The Volcani Institute, ARO, Israel*
OP17	**10:15-10:30**	**Microbial extracts as natural preparations to control postharvest rots of fresh fruits** *Leonardo Schena, "Mediterranea" University of Reggio Calabria, Italy*
OP18	**10:30-10:45**	**Novel strategies to enable breeding for increased resistance to post harvest pathogens** *Suzan Gabriels, Wageningen University & Research, The Netherlands*
	10:45-11:15	Coffee break
	11:15-13:00	**Session IV (continues). Innovative and Sustainable technologies to manage postharvest pathogens** *Moderators: Neus Teixido, Carmit Ziv*
Plenary lecture		
PL5	**11:15-11:45**	**Production, formulation, packaging and shelf life: key aspects for a successful biocontrol agent development** *Neus Teixido, Institute of Agrifood Research and Technology (IRTA), Spain*
Oral Presentations		
OP19	**11:45-12:00**	**Sanitization System in Horticultural sector** *Luca Buglia, Fruit Control Equipments, Italy*
OP20	**12:00-12:15**	**Demonstration of efficacy of a *Pythium oligandrum* product postharvest treatment against fruit rot in apples** *Petr Rubák, Biopreparáty, spol. s r.o, Czech Republic*
OP21	**12:15-12:30**	**Biocontrol strategies in the management of *Cadophora luteo-olivacea*, skin-pitting agent of kiwifruit** *Farwa Jabeen, University of Udine, Italy*

OP22	**12:30-12:45**	**Effect of tobacco leaves (*Nicotiana tabacum*) on the weevil (*Acanthoscelides obtectus*) of common bean (*Phaseolus vulgaris*) in western region, Cameroon** *Henri Grisseur Djoukeng, University of Dschang, Cameroon*
OP23	**12:45-13:00**	**Poinsettia cuttings increase resistance to *Botrytis cinerea* infection over time in propagation** *Melissa Munoz, Clemson University, USA*
	13:00-14:00	Lunch break

Poster Session I (End) *Poster Session II (Start: No 33-64)*
Business meeting

	14:00-14:30	*Poster Session II*
	14:30-16:00	**Session V. Alternative control strategies – non-residual treatments** *Moderators: Lluis Palou, Antonio Ippolito*

Plenary lecture

PL6	**14:30-15:00**	**Alternative control means to extend postharvest life of fresh fruits and vegetables** *Antonio Ippolito, University of Bari Aldo Moro, Italy*

Oral Presentations

OP24	**15:00-15:15**	**Evaluation of hot water and GRAS salt solutions for the control of postharvest gray and green molds of pomegranate fruit** *Lluís Palou, Valencian Institute of Agrarian Research (IVIA), Spain*
OP25	**15:15-15:30**	**A mobile tool for postharvest treatment and preservation of bananas using ozone** *Cyndel Berger, University of Toulouse, France*
OP26	**15:30-15:45**	**Intrinsic variables with antimicrobial activity in Tamr date (*Phoenix dactylifera* L.) during storage** *Zienab FR Ahmed, United Arab Emirates University, United Arab Emirates*
OP27	**15:45-16:00**	**Effect of a hot water treatment and Timorex Golg® in the control of avocado anthracnose** *Jose Luis Henriquez, University of Chile, Chile*
OP28	**16:00-16:15**	**Transcriptomic, Metabolic and Pathogenicity profiling of *Botrytis cinerea* under Cold stress** *Carmit Ziv, The Volcani Institute, ARO, Israel*
	16:15-16:45	Coffee break
	16:45-18:30	**Session V (continues). Alternative control strategies – non-residual treatments** *Moderators: Chris Watkins, Nikolaos Tzortzakis*

Plenary lecture

PL7	**16:45-17:15**	**A critical evaluation of the effects of 1-methylcyclopropene on postharvest disease development** *Chris Watkins, Cornell University, USA*

Oral Presentations

OP29	**17:15-17:30**	**Novel Chitosan/poly-vinyl-alcohol/Thyme oil@Na-montmorillonite and ZnO@Na-montmorillonite edible active coatings for extended self-life of tofu sausages** *Charalampos Proestos, National and Kapodistrian University of Athens, Greece*

OP30	**17:30-17:45**	**Novel Chitosan/polyvinyl alcohol/thyme oil modified nanostructures edible coatings affected cherry tomatoes storage** *Efraimia Hajisolomou, Cyprus University of Technology, Cyprus*
OP31	**17:45-18:00**	**How light wavelengths affect *Monilinia* spp.: from *in vitro* development to virulence on nectarines** *Lucía Verde Yáñez, Institute of AgriFood Research and Technology (IRTA) Fruitcentre, Spain*
Round table discussion section		
	18:00-18:30	**Research directions in postharvest pathology** *Moderator: Samir Droby* *Panel: Science representatives*

Free evening

	09:00	**Departure from Limassol** **Full Day Excursion-Guided tour**
	Visits:	Kourion Theatre Kourion Basilica and Baptistry Kourion Residence of Eustolios Anagyris Park, Essential oil production/uses
	13:00-14:00	Lunch break
		Omodos Village
	18:00	Return to Limassol
	20:00-24:00	**Gala Dinner**

08:00-09:00 **Attendee Registration**
Attaching posters on the board (Poster Session II: No 33-64)

08:45-09:00 **Opening Remarks**
Nikolaos Tzortzakis-Convener

09:00-11:00 **Session VI. Advances and applied research along the supply chain to reduce postharvest losses**
Moderators: Gianfranco Romanazzi, Simona Marianna Sanzani

Plenary lecture

PL8 **09:00-09:30** **New challenges in preventing and managing fresh fruit loss and waste**
Gianfranco Romanazzi, Marche Polytechnic University, Italy

Oral Presentations

OP32 **09:30-09:45** **Alternative means for controlling pomegranate postharvest decay**
Annamaria Mincuzzi, University of Bari Aldo Moro, Italy

OP33 **09:45-10:00** **Essential oils and natural plant extracts as antifungal ingredients of pectin-based edible composite coatings to control green mold and maintain postharvest quality of `Valencia´ oranges**
Maria B. Perez-Gago, Valencian Institute of Agricultural Research (IVIA), Spain

OP34 **10:00-10:15** **Efficacy of biofumigation with essential oils in the control of postharvest rots on nectarines**
Marco Garello, University of Torino. Italy

OP35 **10:15-10:30** **Effects of ozone treatment on postharvest decay of peach fruits in cold storage**
Marwa Moumni, Marche Polytechnic University, Italy

OP36 **10:30-10:45** **Antifungal activity of thirty essential oils to control pathogenic fungi of postharvest decay under cold storage**
Mohamed Bechir Allagui, University of Carthage, Tunisia

OP37 **10:45-11:00** **PRIMA StopMedWaste contribution to postharvest industry**
Clara Montesinos, Decco Ibérica Post-harvest SAU, Spain

11:00-11:30 Coffee break

11:30-12:30 **Session VI (continues). Advances and applied research along the supply chain to reduce postharvest losses**
Moderators: Lise Korsten, Antonios Chrysargyris

Plenary lecture

PL9 **11:30-12:00** **Postharvest microbial shifts of avocado, *Persea americana* Mill. fruit washings using broad-spectrum surface sanitiser and peracetic acid disinfectants**
Lise Korsten, University of Pretoria, South Africa

Oral Presentations

OP38 **12:00-12:15** **OPTIROOT - Optimization of produce quality and storage conditions to reduce loss during long-term storage of root vegetables in Norway ' mapping of stores**
Mette Goul Thomsen, Norwegian Institute of Bioeconomy, Norway

OP39	**12:15-12:30**	**Essential oils and other natural products for the preservation of shredded carrots** *Panayiota Xylia, Cyprus University of Technology, Cyprus*
	12:30-13:30	Lunch break

Poster Session II (End)
Business meeting

13:30-14:30 **ISHS/ISPP Business meeting**

Moderators: Chris Watkins, Haïssam Jijakli, Samir Droby

Report of the ISHS WG Chair and of ISPP WG chair
List of potential candidatures for the next Symposium
Candidates presentation and decision
Nomination or re-nomination of the WG ISHS Chair
ISHS Young Minds Awards
Closing remarks

Abstract Index

Plenary lectures

PL1 **Global postharvest industry, the paradox between the scientific community, the industry and the consumers** **36**
Pauline Voorbraak, Belgium

PL2 **Advanced diagnostics tools to detect and study the epidemiology of postharvest pathogens** **37**
Davide Spadaro, Italy

PL3 **The mechanisms of assembly and dynamics of the microbiome on fruit surfaces – a new understanding of postharvest diseases and their management** **38**
Samir Droby, Israel

PL4 **30 years of biocontrol of postharvest fruit diseases with *Pichia anomala* strain K: Factors affecting efficacy and reliability, including interactions with microbiome** **39**
Haissam Jijakli, Abdoul Razak Sare, Sébastien Massart, Belgium

PL5 **Production, formulation, packaging and shelf life: key aspects for a successful biocontrol agent development** **40**
Neus Teixidó, Josep Usall, Carla Casals, Cristina Solsona, Rosario Torres, Spain

PL6 **Alternative control means to extend postharvest life of fresh fruits and vegetables** **41**
Antonio Ippolito, Italy

PL7 **A critical evaluation of the effects of 1-methylcyclopropene on postharvest disease development** **42**
Chris Watkins, USA

PL8 **New challenges in preventing and managing fresh fruit loss and waste** **43**
Gianfranco Romanazzi, Marwa Moumni, Italy

PL9 **Postharvest microbial shifts of avocado, *Persea americana* Mill. fruit washings using broad-spectrum surface sanitiser and peracetic acid disinfectants** **44**
Lise Korsten, Charlene Coetzee, Stacey Duvenage, South Africa

Oral Presentations

OP1	**High efficacy postharvest plant-based green treatments for citrus decay control** *Javier Parra, Celia Murciano, Benito Orihuel-Iranzo, Spain*	**46**
OP2	**Inoculum release and other factors influencing infection of apples by *Neofabraea vagabunda* (Bull's eye rot)** *Kerry Everett, Luna Hasna, Shamini Pushparajah, Michelle Vergara, Peter Wood, Brent Fisher, New Zealand*	**47**
OP3	**Incidence of postharvest diseases of carrot with special focus on tip rot** *Belachew Asalf, Mirjam Halvorsrud, Berit Nordskog, Norway*	**48**
OP4	**Comparative genomics of the brown rot fungi *Monilinia fructicola*, *M. laxa* and *M. fructigena*** *Rita Milvia De Miccolis Angelini, Lucia Landi, Celeste Raguseo, Stefania Pollastro, Gianfranco Romanazzi, Francesco Faretra, Italy*	**49**
OP5	***Aspergillus carbonarius* lacking veA or pks genes involved in the OTA mycotoxin biosynthesis outcompete the parental strain during both *in vitro* and *in vivo* growth** *Ana-Rosa Ballester, Belén Llobregat, Luis González-Candelas, Spain*	**50**
OP6	**Preliminary epidemiological features of kiwifruit skin pitting agent: *Cadophora luteo-olivacea* (J.F.H. Beyma) T.C. Harr. & McNew)** *Alessandra Di Francesco, Fiorella Neri, Elena Baraldi, Ugo Palara, Paolo Bertolini, Italy*	**51**
OP7	**Strains of *Penicilium expansum* exhibiting Multidrug Resistance phenotype show an overexpression pattern of efflux transporter genes and genes of patulin biosynthesis pathway** *George Karaoglanidis, Panagiota Ntasiou, Anastasios Samaras, Greece*	**52**
OP8	**Unravelling the impact of conventional and organic farming system on Black Aspergilli population structure, mycotoxigenic capacity and mycotoxin contamination assessment in Greek wines, using a new Q-TOF MS-MS detection method** *Stefanos Testempasi, Natalie Kamou, Emmanouil Papadakis, Urania Menkissoglou, George Karaoglanidis, Greece*	**53**
OP9	***Alternaria* spp. causing postharvest decay on apple fruit in Nigde province, Turkey** *Keziban Sinem Tulukoglu Kunt, Sibel Dervis, Mustafa Ozden, Turkey*	**54**
OP10	**Glycosylated flavonoids: fruit's concealed antifungal arsenal** *Pradeep Kumar Sudheeran, Oleg Feygenberg, Dalia Maurer, Noam Alkan, Israel*	**55**
OP11	**Fungal microbiome shifts of avocado fruit from flowering to the ready-to-eat stage** *Malick Bill, Francois Viljoen, Lizyben Chidamba, Lise Korsten, South Africa*	**56**
OP12	**Impact of storage technologies on epiphytic blemishes of apple fruit** *Angelo Zanella, Ines Ebner, Séverine Gabioud Rebeaud, Sabine Öttl, Yazmid Reyes-Dominguez, Italy*	**57**
OP13	**Identification of *Monilinia fructicola* effectors that contribute to peach leaf infection** *Laura Vilanova Torren, Claudio A. Valero-Jiménez, Rosario Torres, Jan A.L. van Kan, Spain*	**58**
OP14	**Natamycin, a new natural compound for postharvest: Opportunities and challenges.** *Geoffroy de Chabot-Tramecourt, Wendy Schotsmans, Belgium*	**59**

OP15	**Phenylalanine: A new inducer improve fruit quality and resistance to postharvest pathogens and chilling injury** *Manish Kumar Patel, Dalia Maurer, Oleg Feygenberg, Noam Alkan, Israel*	**60**
OP16	**Nano-clay particles loaded with double-strand RNA reduces *Botrytis cinerea* colonization and gray-mold in harvested fruits** *Danielle Duanis-Assaf, Ortal Galsurker, Oleg Feygenberg, Dalia Maurer, Noam Alkan, Israel*	**61**
OP17	**Microbial extracts as natural preparations to control postharvest rots of fresh fruits** *Valentina T. Librizzi, Nataly Barger, Sonia Pangallo, Maria G. Li Destri Nicosia, Giovanni E. Agosteo, Imen Belgacem, Ahmed Abdelfattah, Tal Luzzatto-Knaan, Leonardo Schena, Italy*	**62**
OP18	**Novel strategies to enable breeding for increased resistance to postharvest pathogens** *Suzan Gabriels, Paul Arens, Yuling Bai, Arnaud Bovy, Vivianne Vleeshouwers, Richard Visser, Ernst Woltering, The Netherlands*	**63**
OP19	**Sanitization System in Horticultural sector** *Luca Buglia, Italy*	**64**
OP20	**Demonstration of efficacy of a *Pythium oligandrum* product postharvest treatment against fruit rot in apples** *Petr Rubák, Edyta Zajkowska, Czech Republic*	**65**
OP21	**Biocontrol strategies in the management of *Cadophora luteo-olivacea*, skin-pitting agent of kiwifruit** *Farwa Jabeen, Alessandra Di Francesco, Abderraouf Sadallah, Paolo Ermacora, Marta Martini, Italy*	**66**
OP22	**Effect of tobacco leaves (*Nicotiana tabacum*) on the weevil (*Acanthoscelides obtectus*) of common bean (*Phaseolus vulgaris*) in western region, Cameroon** *Henri Grisseur Djoukeng, Yannick Frank Tanku Tedjon, Alphonse Azebaze, Cameroon*	**67**
OP23	**Poinsettia cuttings increase resistance to *Botrytis cinerea* infection over time in propagation** *Melissa Munoz, Paul Millar, James Faust, Guido Schnabel, USA*	**68**
OP24	**Evaluation of hot water and GRAS salt solutions for the control of postharvest gray and green molds of pomegranate fruit** *Lluís Palou, Verònica Taberner, Spain*	**69**
OP25	**A mobile tool for postharvest treatment and preservation of bananas using ozone** *Cyndel Berger, Marielle Pagès-Homs, Léa Volmerange, Pierre Brat, Olivier Hubert, Joel Grabulos, Victoria Bancal, Alain Normand, Aurélien Pugeaux, Luc De Lapeyre de Bellaire, Sylvain Gerbaud, Lucie Nouaillac, Frédéric Violleau, France*	**70**
OP26	**Intrinsic variables with antimicrobial activity in Tamr date (*Phoenix dactylifera* L.) during storage** *Bashaer M T Alkaabi, Suhaila M M Alblooshi, Durray Shahwar, Zienab F R Ahmed, United Arab Emirates*	**71**
OP27	**Effect of a hot water treatment and Timorex Gold® in the control of avocado anthracnose** *José Luis Henríquez, Andrea González, Ysadora Fernández, Chile*	**72**
OP28	**Transcriptomic, metabolic and pathogenicity profiling of *Botrytis cinerea* under cold stress** *Carmit Ziv, Lavanya Gunamalai, Ginat Raphael, Israel*	**73**

OP29	**Novel Chitosan/poly-vinyl-alcohol/Thyme oil@Na-montmorillonite and ZnO@Na-montmorillonite edible active coatings for extended self-life of tofu sausages** *Aris Giannakas, Constantinos Salmas, Eleni Kollia, Anna Kopsacheili, Christina Birlia, Charalampos Proestos, Greece*	**74**
OP30	**Novel Chitosan/polyvinyl alcohol/thyme oil modified nanostructures edible coatings affected cherry tomatoes storage** *Panayiota Xylia, Efraimia Hajisolomou, Antonios Chrysargyris, Katerina Kyriakou, Constantinos Salmas, Aris Giannakas, Charalampos Proestos, Nikolaos Tzortzakis, Cyprus*	**75**
OP31	**How light wavelengths affect *Monilinia* spp.: from *in vitro* development to virulence on nectarines** *Lucía Verde Yáñez, Núria Vall-llaura, Josep Usall, Neus Teixidó, Rosario Torres, Spain*	**76**
OP32	**Alternative means for controlling pomegranate postharvest decay** *Annamaria Mincuzzi, Simona Marianna Sanzani, Marika Caputo, Pasquale D'Ambrosio, Lluìs Palou, Marco Ragni, Antonio Ippolito, Italy*	**77**
OP33	**Essential oils and natural plant extracts as antifungal ingredients of pectin-based edible composite coatings to control green mold and maintain postharvest quality of `Valencia´ oranges** *María V. Alvarez, Lluís Palou, Verónica Taberner, Asunción Fernández-Catalán, Victoria Martínez-Blay, Maricruz Argente-Sanchis, María B. Pérez-Gago, Spain*	**78**
OP34	**Efficacy of biofumigation with essential oils in the control of postharvest rots on nectarines** *Giada Schiavon, Marco Garello, Davide Spadaro, Italy*	**79**
OP35	**Effects of ozone treatment on postharvest decay of peach fruits in cold storage** *Annamaria L. D'Ortenzio, Sarah Mojela Makau, Valeria Mancini, Simone Piancatelli, Marwa Moumni, Lucia Landi, Gianfranco Romanazzi, Italy*	**80**
OP36	**Antifungal activity of thirty essential oils to control pathogenic fungi of postharvest decay under cold storage** *Marwa Moumni, Ibtissem Hannachi, Hajer Ben Amara, Gianfranco Romanazzi , Mohamed Bechir Allagui, Tunisia*	**81**
OP37	**PRIMA StopMedWaste contribution to postharvest industry** *Clara Montesinos, Spain*	**82**
OP38	**OPTIROOT - Optimization of produce quality and storage conditions to reduce loss during long-term storage of root vegetables in Norway ' mapping of stores** *Mette Goul Thomsen, Erlend Indergaard, Belachew Asalf, Pia Heltoft, Norway*	**83**
OP39	**Essential oils and other natural products for the preservation of shredded carrots** *Panayiota Xylia, Antonios Chrysargyris, George Botsaris, Nikolaos Tzortzakis, Cyprus*	**84**

Poster Presentations

PP1	**Postharvest fungal pathogens of apple in Nigde province, Turkey** *Keziban Sinem Tulukoglu Kunt, Mustafa Ozden, Sibel Dervis, Turkey*	**86**
PP2	**Etiology of fungal decay during the controlled atmosphere storage of 'Fuji' and 'Gala' under commercial conditions** *Rachael Maree Wood, Luiz Carlos Argenta, Marcelo José Vieira, Claudio Ogoshi, Daniel Alexandre Neuwald, Germany*	**87**
PP3	**Assessment of sensitivity to boscalid, fluopyram and tebuconazole in *Monilinia fructicola* isolates obtained from peach orchards in Greece** *Stefanos Testempasis, Vasiliki Tsintila, George Karaoglanidis, Greece*	**88**
PP4	**Detection and identification of fungal storage pathogens on apples before and after harvest in Austria** *Ulrike Persen, Richard A. Gottsberger, Thomas Leichtfried, Juliane Reiterer, Austria*	**89**
PP5	**First genome sequences of *Neofabraea* species responsible for anthracnose, perennial canker and post-harvest bull's eye rot of apple** *Greice Amaral Carneiro, Sanja Baric, Selena Tomada, Andreas Bühlmann, Switzerland*	**90**
PP6	**Patulin-deficient knockout mutants of *Penicillium expansum* as potential biocontrol agents** *Belén Llobregat, Luis González-Candelas, Ana-Rosa Ballester, Spain*	**91**
PP7	**Genetic diversity and pathogenicity of *Diaporthe* spp. causing hazelnut defects of hazelnut nuts from Italy** *Muhammad Waqas, Alan Pizzinat, Vladimiro Guarnaccia, Davide Spadaro, Italy*	**92**
PP8	**Identification and pathogenicity of the causal agent(s) of black vein of Swede** *Belachew Asalf, Juliana Perminow, Vinh Hong Le, Inger-Lise Akselsen and Berit Nordskog, Norway*	**93**
PP9	**Diagnostic analysis of post-production losses of tomato (*Solanum lycopersicum*) in the Menoua division, West region of Cameroon** *Henri Grisseur Djoukeng, Whitney Rakelle Anguezomo Assoumou, Nestor Lindou Peyoumeya, Cameroon*	**94**
PP10	**Bacterial endophytes as a biocontrol agent against mycotoxigenic fungi of cereals** *Vijay Kumar Sharma, Ajay Kumar, V. Yeka Zhimo, Shoshana Salim, Oleg Feygenberg, Edward Sionov, Samir Droby, Israel*	**95**
PP11	**Changes in gene expression and postharvest decay inhibition of papaya (*Carica papaya* L.) treated with chitosan and *Ruta graveolens* L. essential oil alone and in combination** *Lucia Landi, Yeimmy Yolima Peralta Ruiz, Clemencia Chaves Lopez, Gianfranco Romanazzi, Italy*	**96**
PP12	**Molecular identification of *Monilinia laxa*, *Monilinia fructigena* and *Monilinia fructicola* from stone fruits in the Marche Region, Central-Eastern Italy** *Sarah Mojela Makau, Annamaria L. D'Ortenzio, Valeria Mancini, Sergio Murolo, Lucia Landi, Gianfranco Romanazzi, Italy*	**97**
PP13	**Mycotoxins' role in host tissue colonization by producing fungi** *Simona Marianna Sanzani, Massimo Reverberi, Italy*	**98**

PP14 **A Sweet Battle- The effect of tomato fruit sugar level on the pathogenicity mechanism and host response during infection of two postharvest fungal pathogens** **99**
Carmit Ziv, Noa Sela, Arthu Schaffer, Dov Prusky, Israel

PP15 **Microbiome shifts during the developmental stages from flowering to ready-to-eat mango fruit** **100**
Malick Bill, Lizyben Chidamba, Jarishma Keriuscia Gokul, Lise Korsten, South Africa

PP16 **Microbiome alteration in fruit following application of the yeast biocontrol agent *Metschnikowia fructicola*** **101**
V. Yeka Zhimo, Oleg Feygenberg, Shoshana Salim, Ajay Kumar, Vijay Kumar Sharma, Samir Droby, Israel

PP17 **Unraveling plant responses triggered by *Botrytis cinerea* in strawberry fruit during ripening** **102**
Yijie Zhao, Maarten Hertog, Bart Nicolaï, Barbara De Coninck, Belgium

PP18 **Using SIFT-MS to evaluate the quiescent infection of strawberry fruit by *Botrytis cinerea*** **103**
Yijie Zhao, Maarten Hertog, Bart Nicolaï, Barbara De Coninck, Belgium

PP19 **The active role of *Botrytis cinerea* on Inoculated-tomatoes postharvest ripening: Physiological and proteomic approaches** **104**
Nikolaos Tzortzakis, Cyprus

PP20 **Functional analysis of putative effector-encoding genes from the post-harvest pathogen *Penicillium digitatum*** **105**
Víctor Silva-Alejandre, Elena Levin, Samir Droby, Luis González-Candelas, Ana-Rosa Ballester, Spain

PP21 **Postharvest application of natural compounds and biocontrol agents to control brown rot of stone fruit** **106**
Annamaria L D'Ortenzio, Giacomo Fava, Stefano Mazzoni, Paolo Acciarri, Luciano Baronciani, Gianni Ceredi, Gianfranco Romanazzi, Italy

PP22 **Effect of light intensity on ecophysiological parameters of *Monilinia* spp. and on brown rot development on stone fruit** **107**
Marta Balsells-Llauradó, Rosario Torres, Núria Vall-llaura, Carla Casals, Neus Teixidó, Josep Usall, Spain

PP23 **The plant extracts as bio-fungicide against strawberry *Botrytis cinerea*** **108**
Alma Valiuskaite, Neringa Rasiukeviciute, Lina Dene, Simona Chrapaciene, Giedre Samuoliene, Akvile Virsile, Viktorija Vastakaite-Kairiene, Jurga Miliauskiene, Kristina Lauzike, Ruta Sutuliene, Ausra Brazaityte, Lithuania

PP24 **Effect of a zero-residue crop protection strategy on yield, fruit quality and pre- and post-harvest diseases of strawberries** **109**
Marco Garello, Giada Schiavon, Marco Rosati, Davide Spadaro, Italy

PP25 **Controlling `White haze´ disease under *in vitro* controlled conditions** **110**
Dario Angeli, Lorenzo Turrini, Fabio Zeni, Tomas Roman, Italy

PP26 **Contribution of light wavelengths to melanin biosynthesis in *Monilinia* spp. causes of brown rot in nectarine** **111**
Lucía Verde Yáñez, Josep Usall, Núria Vall-llaura, Neus Teixidó, Rosario Torres, Spain

PP27 **Sensitivity of *Penicillium digitatum* and *Penicillium italicum* populations from citrus fruits in Chile to imazalil, fludioxonil and pyrimethanil** **112**
José Luis Henríquez, Ysadora Fernández, Marcelo Bustamante, Chile

PP28 **An epiphytic basidiomycetous yeast as biocontrol agent of *Penicillium expansum*** **113**
Simona Marianna Sanzani, Michele Sgaramella, Saveria Mosca, Michele Solfrizzo, Antonio Ippolito, Italy

PP29 **Improving microbiological quality and storage life of date fruit using gamma irradiation** **114**
Durray Shahwar, Roheena Abdullah, Zienab F R Ahmed, United Arab Emirates

PP30 **The double face of *Butlerelfia eustacei* – a post-harvest pathogen or a potential biocontrol agent?** **115**
Selena Tomada, Greice Amaral Carneiro, Alberto Storti, Sanja Baric, Italy

PP31 **Nanoencapsulation of bioactive substances of aromatic and pharmaceutical plants for use in the production of: (a) biological foods & food supplements (b) animal health protection products (c) plant protection products** **116**
Konstantina Pasvanka, Stergios Tzimikas, Konstadina Papastavropoulou, Charalampos Proestos, Greece

PP32 **Preharvest application of natural compounds on postharvest quality and gray mold of strawberry** **117**
Antonios Chrysargyris, Razieh Rajestary, Panayiota Xylia, Gianfranco Romanazzi, Nikolaos Tzortzakis, Cyprus

PP33 **Effect of postharvest treatment on physiological disorders of new apple varieties** **118**
Dario Angeli, Lorenzo Turrini, Fabio Zeni, Tomas Roman, Italy

PP34 **Will cannabinoids be the next antifungal agents against postharvest pathogenic fungi?** **119**
Danielle Duanis-Assaf, Mark Feldman, Dalia Maurer, Oleg Feygenberg, Raphael Mechoulam, Doron Steinberg, Noam Alkan, Israel

PP35 **Effect of calcium compounds *in vitro* on two fungal pathogens causing postharvest rots of pepper** **120**
Charles Krasnow, Carmit Ziv, Israel

PP36 **Alternative methods for the control of the most resistant isolate of *Penicillium digitatum* to Imazalil isolated from mandarin fruits** **121**
Emilia Nuñez, Liliana Aragon, Andres V. Casas Diaz, Peru

PP37 **Antifungal activity of Apulian seaweed extracts** **122**
Annamaria Mincuzzi, Anna Lisco, Marika Caputo, Nunzio Dipierro, Antonio Ippolito, Antonella Bottalico, Italy

PP38 **LED-light technologies for *Botrytis cinerea* inhibition** **123**
Neringa Rasiukeviciute, Alma Valiuskaite, Lina Dene, Simona Chrapaciene, Giedre Samuoliene, Akvile Virsile, Viktorija Vastakaite-Kairiene, Jurga Miliauskiene, Kristina Lauzike, Ruta Sutuliene, Ausra Brazaityte, Lithuania

PP39 **Ripe indexes, hot water treatments, and biocontrol agents as synergistic combination to control apple bull's eye rot** **124**
Alessandra Di Francesco, Nicola Placì, Beatrice Scialanga, Gianni Ceredi, Elena Baraldi, Italy

PP40 **Non-thermal plasma as a new alternative technology for effective control of postharvest fungal pathogens** **125**
Palma Rosa Rotondo, Caterina Rotolo, Paolo Francesco Ambrico, Marianna Ambrico, Donato Gerin, Stefania Pollastro, Francesco Faretra, Rita Milvia De Miccolis Angelini, Italy

PP41 **The efficacy of conventional postharvest treatments on *Rosmarinus officinalis* shelf life** **126**
Constantinos Stefanou, Panayiota Xylia, Antonios Chrysargyris, Nikolaos Tzortzakis, Cyprus

PP42 **Use of nitric oxide as a strategy for postharvest controlling blue mold in 'Cripps Pink' apples** **127**
Paulo Sérgio Gularte, Felix Büchele, Janaiana Catarina da Silva, Samara Martins Zanella, Rachael Maree Wood, Cassandro Vidal Talamini do Amarante, Daniel Alexandre Neuwald, Cristiano André Steffens, Germany

PP43 **Incidence of physiological and pathogen related storage disorders in three apple varieties under different storage methods** **128**
Felix Büchele, Fabio Rodrigo Thewes, Daniel Alexandre Neuwald, Germany

PP44 **Postharvest strategies for controlling fungal pathogens during storage of organically grown `Topaz´ apple** **129**
Daniel Alexandre Neuwald, Rachael Maree Wood, Ricardo Bauer Pilla, Adriano Arriel Saquet, Felix Büchele, Bruno Pansera-Espíndola, Denise Schmidt, Germany

PP45 **Reducing post-harvest losses in organic beetroot production in Switzerland** **130**
Pascale Flury, Clémence Boutry, *Patricia Schwitter, Martin Koller, Anja Vieweger, Hans-Jakob Schärer, Switzerland*

PP46 **Qualitative analyses and antifungal prospective of pomegranate juices and waste** **131**
Annamaria Mincuzzi, Graziana Difonzo, Davide Campobasso, Marika Caputo, Pasquale D'Ambrosio, Rosalinda Surico, Carmine Summo, Antonio Ippolito, Italy

PP47 **Effect of CMC-Beeswax composite edible coating amended with antifungal agents on physicochemical proprieties of nectarine fruits during cold storage** **132**
Marwa Moumni, Ibtissem Hannachi, Hajer Ben Amara, Gianfranco Romanazzi, Mohamed Bechir Allagui, Tunisia

PP48 **Antifungal edible coatings to control Alternaria black spot and maintain the quality of 'Rojo Brillante' persimmon during cold storage** **133**
Asunción Fernández-Catalán, Lluís Palou, Verónica Taberner, Amparo Grimal, Maricruz Argente-Sanchis, Maria B. Pérez-Gago, Spain

PP49 **Ozone as an alternative method to control postharvest diseases on strawberries** **134**
Séverine Gabioud Rebeaud, Véronique Varone, André Ançay, Danilo Christen, Switzerland

PP50 **Preservation of fresh strawberries in an ozone-enriched atmosphere** **135**
Nikolaos Tzortzakis, Cyprus

PP51 **Improvement of fruit quality by continuous ozone exposure during storage** **136**
Cyndel Berger, Marielle Pagès-Homs, Léa Volmerange, Séverine Maldes, Vincent Quintard, Frédéric Violleau, France

PP52 **Essential oil-based formulations for the control of postharvest brown rot** **137**
Jovana Hrustic, Brankica Tanovic, Slavica Gasic, Milica Mihajlovic, Marija Stevanovic, Serbia

PP53 **The impacts of rosemary and eucalyptus essential oils and their major component use on the preservation of apple and pear fruits** **138**
Panayiota Xylia, Antonios Chrysargyris, Nikolaos Tzortzakis, Cyprus

PP54 **Use of essential oils from *Eucalyptus globulus* and *Pistacia lentiscus* as an additive to the holding solution of *Chrysanthemum indicum* cut flowers** **139**
Georgios Toumazou, Panayiota Xylia, Michalis Makrygiorgis, Antonios Chrysargyris, Cyprus

PP55 **Unexplored endemic species of medicinal and aromatic plants as a potential source of natural sanitizers and antioxidants: the case of *Sideritis cypria* Post** **140**
Chrysargyris Antonios, Ekaterina-Michaela Tomou, George Toumazou, Panagiota Miltiadous, Panayiota Xylia, Helen Skaltsa, Nikolaos Tzortzakis, Cyprus

PP56 ***In vitro* effect of eucalyptus and rosemary essential oils and eucalyptol against *Fusarium oxysporum* and *Botrytis cinerea*** **141**
Efraimia Hajisolomou, Panayiota Xylia, Antonios Chrysargyris, Nikolaos Tzortzakis, Cyprus

PP57 ***In vitro* antifungal activity of commercial essential oils in vapor phase against *Monilinia fructicola* and *Botrytis cinerea*** **142**
Samuel Alvarez-García, Marwa Moumni, Gianfranco Romanazzi, Spain

PP58 **Preliminary research regarding thermal treatments applied to the bean seeds** **143**
Eliza Teodorescu, Romania

PP59 **Postharvest fungal pathogens of peach fruit in Serbia** **144**
Jovana Hrustic, Milica Mihajlovic, Brankica Tanovic, Serbia

PP60 **The possibilities for Hungarian sour cherries for storage and elongation of fresh consumption** **145**
Kata Mihály, Erzsébet Szöllösi, Judit Rita Homoki, Antal Nagy, Ferenc Takács, Ezsébet Sándor, Hungary

PP61 **Effect of maturity in carrot (*Daucus carota* ssp. sativus) on storage diseases after long time storage** **146**
Pia Heltoft, Mette Goul Thomsen, Norway

PP62 **Oregano, ironwort and sage herbs extracts towards common foodborne pathogens** **147**
Panayiota Xylia, Antonios Chrysargyris, Panagiota Miltiadous, Nikolaos Tzortzakis, Cyprus

PP63 **The use of *Origanum dubium* as sanitizing agent against *Salmonella enterica* and *Listeria monocytogenes* on tomato and cucumber** **148**
Panayiota Xylia, Antonios Chrysargyris, Panagiota Miltiadous, Nikolaos Tzortzakis, Cyprus

PP64 **Development of a smart tomato for physiological sensing and fruit quality assessments along the supply chain** **149**
Malick Bill, Lungelo Ntamane, Andre Broekman, Wynand JvdM Steyn, Lise Korsten, South Africa

Plenary Lectures

PLE-1

Global postharvest industry, the paradox between the scientific community, the industry and the consumers

Pauline Voorbraak

Janssen PMP (Preservation and Material Protection), Janssen Pharmaceutica NV, Turnhoutseweg 30, 2340 Beerse, Belgium. Email: pvoorbra@its.jnj.com

Abstract

Postharvest processing is a critical step in the preservation and shelf life extension of fruits. All publications describing postharvest, often insist on the huge waste of fresh produce at global level because of non-optimum postharvest practices. This presentation will describe the actual use of plant protection products in postharvest processing, their advantages and disadvantages under the light of what end-users demand. What is currently on the market is a partial answer to market demand. During the Corona crisis, the demand for fresh produce increased significantly at global level. In the meantime, consumers request less pesticides on their fruits and vegetables. But what the alternative to postharvest crop protection products are? The presentation will intent to answer that question from different angles. First, the scientific aspect comparing a number of natural compounds with synthetic chemicals from efficacy viewpoint. For instance, why essential oils have advantages and disadvantages compared to pyrimethanil. The presentation will also explain why the industry and end-users need the scientific community. But the scientific community needs also end-users to make sure innovations fit with market needs. Some examples will be described in order to illustrate that statement. How the fruits and the vegetable postharvest industry will look like in 2030 or in 2040? Will it be the same as today? Are we going to live an acceleration of the number of innovations placed on the market? Some answers will be provided during this presentation. If we assume that the world population will consume to grow, the risk of global pandemic will remain strong, the life standard will keep increasing, then we can assume as well that demand for fresh quality produce will also grow. Are consumers willing to pay more for fresh quality produce? And is there tendency that consumers care more about their health? Therefore, the magic triangle composed with the scientific community, the industry and end-users should function perfectly well. Is that the case today? The presentation will try to bring answers to this question and will bring an opinion of an industry player.

Keywords: Pesticides, alternative technologies, innovation, research, regulatory

PLE-2

Advanced diagnostics tools to detect and study the epidemiology of postharvest pathogens

Davide Spadaro

DISAFA and AGROINNOVA, University of Torino, 10095 Grugliasco, Italy. Email: davide.spadaro@unito.it

Abstract

Fruit and nuts can be attacked by different pathogens during the postharvest phase. Some fungal pathogens can infect the host during the postharvest phase, whereas other penetrate the fruit in preharvest and develop symptoms during the fruit storage. Molecular diagnostics is an effective tool to detect postharvest pathogens. One of the most critical points in the DNA-based methods is the selection of a correct genetic marker or barcode, which is informative enough to obtain a species-level identification or even sub-species identification. Primers and probes should be designed to amplify the target DNA for a qualitative or quantitative polymerase chain reaction (PCR or qPCR). A qPCR could be applied for early detection of asymptomatic samples, thanks to its sensitivity. In-field detection methods need to be specific and sensitive, easy to be interpreted and simple for the end-user. Isothermal methods, such as loop-mediated isothermal amplification (LAMP), present some advantages in contrast to PCR-based methods. Examples of recently developed diagnostic tools for *Aspergillus flavus*, *Monilinia fructicola* and *Venturia inaequalis* will be considered. Besides, also metabarcoding and metagenomics have the potential to be used to monitor and detect postharvest pathogens, but also to study their epidemiology. Metabarcoding has been used to clarify the main agents of white haze and to understand when *Ramularia mali*, the agent of dry lenticel rot, appear on or in the fruit. These findings provide interesting information about the epidemiology of some postharvest pathogens, which is important to develop specific diagnostics and adequate management strategies.

Keywords: Diagnostics, postharvest, pathogens, PCR, qPCR, LAMP, metagenomics, metabarcoding

PLE-3

The mechanisms of assembly and dynamics of the microbiome on fruit surfaces – a new understanding of postharvest diseases and their management

Samir Droby

Department of Postharvest Science, The Volcani Institute, ARO, Rishon LeZion 7505101, Israel. Email: samirdroby@hotmail.com

Abstract

The microbial ecology of fruit associated microbes lags behind that of other plant-associated microbial communities. Determining the host factors that influence fruit surface microbiome assembly and dynamics is crucial to unravel the basic ecological processes involved in the disease process of postharvest pathogens. In our recent studies, we found a greater host effect of fruit stage over genotype in shaping the fruit microbiome structure, characterized by strong community succession. We also see a set of core members that persists throughout the fruit stages and identified some of these members exhibiting differential abundances at specific stages. We demonstrate that the turnover pattern dominates over its antithetic nestedness pattern in driving community succession during the fruit developmental stages and lead to taxonomic homogenization after harvest during storage. We report for the first time, the existence of an underlying universal dynamic model in fruit-associated microbiome assemblies. We provide evidence of microbial cross-domain interactions by showing strong correlations in diversities and community composition and detect some microbe-microbe co-occurrences. Additionally, we show that disease process on harvested fruit is complex and may involve, besides the pathogens, other components of the microbiome. In this relation, the "pathobiome" concept will be discussed.

Keywords: Microbiome, postharvest, biocontrol

PLE-4

30 years of biocontrol of postharvest fruit diseases with *Pichia anomala* strain K: Factors affecting efficacy and reliability, including interactions with microbiome

Haissam Jijakli, Abdoul Razak Sare, Sébastien Massart

Laboratory of Integrated and Urban Phytopathology, University of Liège, 5030 Gembloux, Belgium. Email: mh.jijakli@uliege.be

Abstract

Harvested fruits and vegetables are threatened by pathogens which can cause losses for up to 55% depending on the fruit and country. A potentially sustainable control method is the biological control of these postharvest diseases using biocontrol agents (BCA). Nevertheless, the lack of reliability in practical conditions compared with synthetic chemical pesticides is a major hinderance. Many BCA were isolated to control fruit postharvest pathogens like wounds pathogens *Botrytis cinerea* and *Penicillium* spp. One of these BCA is the yeast *Pichia anomala* strain K. From 1991 to 2016, its mode of action and ecology have been studied by a range of tools, from microbiological, biochemical, physical parameters screening, practical application, transcriptomics, proteomics, down to genetic and genetic transformation. These characterisation studies allowed to settle down a formulation which increased its efficacy. During the last five years, apple microbiota was deeply characterized and engineered to improve the efficacy and stability of *Pichia anomala* strain K against *B. cinerea* rot. Eighteen apple microbial communities (from 15 cultivars differentially treated against diseases) were harvested and characterized by metabarcoding, biocontrol efficacy experiments and profiling of 190 carbon sources metabolization. Results showed that apple microbiota is diversified and contrasted at taxonomic level, biocontrol efficacy and carbon source profile. Microbiota significantly raised the strain K efficacy up to 100%, and its alpha diversity was not correlated to the biocontrol efficacy. Co-clustering of Spearman correlations was used to drive the isolation of promising beneficial strains (strain K's helper strains and new BCA) and prebiotics molecules. Potential helper strains and new BCA were isolated. Prebiotic of biocontrol were identified with up to 62% efficacy increase in the presence of apple whole microbiota. This constitutes an original report of engineering whole fruit microbiota to identify probiotic and prebiotic to strengthen the biocontrol of BCA against postharvest diseases.

Keywords: Biocontrol, yeast, *Pichia anomala*, *Botrytis cinerea*, mode of action, microbiome, HTS

PLE-5

Production, formulation, packaging and shelf life: key aspects for a successful biocontrol agent development

Neus Teixidó, Josep Usall, Carla Casals, Cristina Solsona, Rosario Torres

Institute of Agrifood Research and Technology (IRTA), Postharvest Program, 25003 Lleida, Catalonia, Spain. Email: neus.teixido@irta.cat

Abstract

Biocontrol agents (BCAs) have been proposed and studied in the last decades as suitable alternatives to reduce or replace the chemicals applied for control pre- and postharvest diseases of fruit. However, the development of BCAs has many constraints and obstacles to be overcome before they could be successfully implemented in the market. For the commercial development as BCA products, microorganisms should be mass-produced at large-scale, and efficiently formulated, in order to have a final product long-term stable, easily handled and, of course, consistently effective to control target diseases. In this lecture, we will review this complex process to obtain biocontrol products, with particular attention to production, formulation, packaging, and shelf-life of BCAs that can be used in pre and postharvest applications for controlling fungal diseases of fruit. The methods used for industrial scale-up production are solid- or liquid- phase fermentation, and the main goal is to achieve a high biomass production at the lowest cost. A wide variety of formulation types have been developed for BCAs. However, a general procedure does not exist, and the process must be optimized for each strain: liquid or solid formulation, dehydration system (freeze-drying, spray-drying, fluidized bed-drying, and fluidized bed-spray drying) and adjuvants addition if necessary. Formulated product includes: the active ingredient (cells, produced metabolites or both), carriers (inert materials that support and deliver de active ingredient) and protectants or adjuvants, which sustain the function of the active ingredient by protecting it from high temperatures, desiccation, ultraviolet radiation, … and/or promote the spread and dispersal of the product improving application. Finally, a careful selection of the packaging materials and conditions should be considered to extend, preferably, up to two years the shelf-life of formulated product.

Keywords: Antagonist, bioreactor, drying, adjuvants, storage, stability, commercial bio-product

PLE-6

Alternative control means to extend postharvest life of fresh fruits and vegetables

Antonio Ippolito

Department of Soil, Plant, and Food Sciences, University of Bari Aldo Moro, Via Amendola 165/A, 70126 Bari, Italy. Email: antonio.ippolito@uniba.it

Abstract

Postharvest diseases are responsible for direct losses of fresh fruits and vegetables, with up to 50-60% of produce. Pathogenic fungi belonging to the genera *Alternaria, Aspergillus, Botrytis, Fusarium, Monilia, Penicillium, Rhizopus*, are the main causal agents of postharvest deterioration. Some of these fungi are also responsible for production of mycotoxins contaminating food and feed and thus dangerous for human and animal health. Traditionally, chemical fungicides have been used effectively to ensure high quality of fruits and vegetables over extended periods of storage or transportation. However, the increased global chemophobia and the reduced efficacy of chemicals due to pathogen resistant strains, have forced producers to evaluate more safe and effective alternatives for controlling postharvest diseases in a context of sustainable agriculture. Furthermore, the increasingly restrictive international regulations are pushing in this direction. Several means, such as natural compounds of animal and plant origin, organic and inorganic salts, antagonistic/beneficial microorganisms, elicitors to induce natural host defenses, and various physical approaches, all of them applied near harvest and/or during postharvest represent some of the strategies recently evaluated, and to some extent already applied, to ensure top fruit quality. Recent success in choosing and testing the effectiveness of new approaches are also made possible by multi-omic technologies facilitating the understanding of the complex interactions among actors involved in postharvest disease development and control. This talk deals with the substantial progress obtained by researchers in the use of alterative control means, also considering constraints and obstacles still making difficult their large diffusion and practical application.

Keywords: Postharvest, fungi, loss, alternative control means

PLE-7

A critical evaluation of the effects of 1-methylcyclopropene on postharvest disease development

Chris Watkins

Horticulture Section, School of Integrative Plant Science, College of Agriculture and Life Sciences, Cornell University, Ithaca, NY14853, USA. Email: chris.watkins@cornell.edu

Abstract

1-Methycyclopropene (1-MCP), an inhibitor of ethylene perception, is commercially available worldwide. Most research on 1-MCP, however, has focused on its effects on ripening and/or senescence of horticultural products, with only limited focus on disease development. The literature reveals that 1-MCP can inhibit, stimulate, or have no effect on disease incidence and severity. The effects of 1-MCP can be further complicated by concentration where for example, high and low concentration treatments strawberry can inhibit and decrease disease incidence, respectively. Inhibition of disease is typically associated with effects of 1-MCP on ripening/senescence where host defenses to infection are maintained. Few studies show direct effects of 1-MCP on spore germination and mycelium growth. More recently, 1-MCP has been used to investigate ethylene mediated pathogenicity. The literature reveals a number of very diverse approaches that are taken by plant pathologists compared with postharvest physiologists. These include studies on the effects of 1-MCP on disease development that take little account of fruit physiology, especially the commercial acceptability of the product; experimental design based on inoculation and keeping products at non-storage temperatures; and claims of inhibition that are either inconsistent or seemingly trivial, such as 95% to 81% disease incidence. The need for more collective approaches by postharvest pathologists and physiologists is highlighted.

Keywords: Ethylene, fruits, vegetables, 1-MCP, disease, physiology

PLE-8

New challenges in preventing and managing fresh fruit loss and waste

Gianfranco Romanazzi, Marwa Moumni

Marche Polytechnic University, Department of Agricultural Food and Environmental Sciences, Via Brecce Bianche, 60131 Ancona, Italy. Email: g.romanazzi@univpm.it

Abstract

Food loss and waste is an issue of importance to global food security, as 690 million people were hungry or undernourished and three billion cannot afford a healthy diet. One third of all food produced, equal to 1.3 billion tons, is lost or wasted every year, including about 45% of all fruit and vegetables. Food loss and waste is a major societal, economic, nutritional, and environmental challenge. This waste occurs along the entire food chain (from field to consumer) and need to be analysed and monitored due to their impact on the development of the food sector. Reduction of Food loss and waste is a target of the Sustainable Development Goals (SDGs) of the United Nations, and the Farm to Fork Strategy of the European Green Deal. In addition, fresh fruit loss and waste prevention, and management are included among the 17 SDGs (targets 12.2 and 12.3), within Agenda 2030 for Sustainable Development. According to Food and Agriculture Organization of the United Nations (FAO), annually plant diseases cost the global economy around $220 billion. Fresh fruit and vegetables are highly perishable, and once harvested, they need to be handled using appropriate technologies to maintain their quality and prolong shelf life. A quantification of the amount of fresh fruit loss and waste is fundamental to the development of effective prevention and reduction strategies. The strategic management of technology and innovation will be delineated for high quality fresh fruit, thus improving the food supply chain, and at the same time, minimising the application of synthetic pesticides. Reducing fresh fruit loss and waste can help to decrease the pressure on food production systems, particularly within the context of threatened natural resources and climate change. Reducing food loss and waste is an important strategy for promoting more sustainable food systems and addressing global food insecurity.

Keywords: Food and nutrition security, food systems, fresh fruit and vegetable waste quantification, natural resources, sustainability

PLE-9

Postharvest microbial shifts of avocado, *Persea americana* Mill. fruit washings using broad-spectrum surface sanitiser and peracetic acid disinfectants

Lise Korsten, Charlene Coetzee, Stacey Duvenage

Department of Plant and Soil Sciences, University of Pretoria, Hatfield, 0002, Pretoria, South Africa. Email: lise.korsten@up.ac.za

Abstract

Microbiome studies have enabled scientists to get a better understanding of microbial population shifts, species richness and diversity due to interventions, practices and environmental conditions. Natural microbial populations provide a protective base against postharvest pathogens causing spoilage, protection i.e. *Bacillus* spp. or foodborne pathogens i.e. *Listeria mynocotogenes* which is more of food safety concern. Retaining fruit quality and safety is thus reliant on efficient sanitizing that will not disrupt the natural microbial balance but prevent pathogen persistence. The study aimed to determine the consistency of commercial fruit washings on bacterial microbiomes and the effectiveness of sanitizers to retain the pathogen free status of fruit. Sixty avocado fruit were sampled two-weekly at commercial facilities during the harvesting season and out of season for microbial analysis, DNA extraction and Illumina sequencing. Operational taxonomic units reflected on important phyla i.e. Proteobacteria, Bacteroidetes, Actinobacteria, Firmicutes and Acidobacteria. Diverse bacterial communities were associated with avocado fruit and differences in relative abundance of taxa were found between stored and washed fruit. Bacterial taxa associated with the avocado carpoplane were more diverse in season than out of season fruit that was first cold stored. These findings indicate that microbial diversity decreases during fruit storage. The paper will provide a further overview of other alternative approaches such as UV-C and biosensors to improve fruit quality.

Keywords: Bacterial microbiome, *Persea americana*, fruit washing, disinfectant, sanitiser

Oral Presentations

OP-1

High efficacy postharvest plant-based green treatments for citrus decay control

Javier Parra, Celia Murciano, Benito Orihuel-Iranzo

Productos Citrosol, Partida Alameda Parc C, 46721 Valencia Potries, Spain. Email: jparra@citrosol.com

Abstract

The postharvest control of citrus main pathogens (*Penicillium digitatum* and *Penicillium italicum*) is still mainly dependent on the use of synthetic chemical fungicides, such as imazalil, o-phenylphenol, thiabendazole or pyrimethanil, among others. However, the widespread use of chemicals is becoming gradually questioned and restricted because of concerns about environment, consumer health and development of resistances, which has increased the demand for chemical-free fruit or ECO-certified fruit. As a result, decay control methods without synthetic fungicides are needed, and treatments based on natural products, such as inorganic salts or plant extracts, the so called “green chemistry” treatments, could be an alternative. To avoid losses, besides minimal toxicity and environmental impact, these treatments should have high decay control efficacy. “Green chemistry” treatments are usually less effective than conventional fungicide treatments, have a higher industrial variability and little residual effect over time. Citrosol has developed a “green” drencher/tank treatment, based on plant-based proprietary formulation Greencide®, with high efficacy in decay control, reduced variability, and residual effect even in prolonged storage periods. A narrow efficacy range of 80-96% after 7 days of shelf life test (20 ºC, 85% RH) was obtained from a set of a number of independent experiments applying Greencide® treatments on artificially inoculated *Penicillium digitatum* fruit, similar to the one obtained with reference conventional treatment with imazalil (89-100%), both with efficacy sustained over time, whereas Citrosol standard alternative treatment without synthetic fungicides (based on inorganic salts and food additives) showed 50-100% and current Citrosol ECO-certified treatment (based on peracetic acid + sodium bicarbonate) showed 20-66%. Greencide® is pending registration and ECO certification. These treatments complemented with Citrocide® PC peracetic acid disinfection (ECO-certified) in the washing machine and a proper waxing with PlantSeal® coatings (ECO and vegan certified), will contribute to achieve excellent arrivals to distant destinations using only “green chemistry”.

Keywords: Green chemistry, green treatments, plant-based, citrus decay control, *Penicillium digitatum*

OP-2

Inoculum release and other factors influencing infection of apples by *Neofabraea vagabunda* (Bull's eye rot)

Kerry Everett, Luna Hasna, Shamini Pushparajah, Michelle Vergara, Peter Wood, Brent Fisher

Bioprotection, The New Zealand Institute for Plant and Food Research Limited, PB 92169, 1142 Auckland, New Zealand. Email: kerry.everett@plantandfood.co.nz

Abstract

Apple lenticels are symptomlessly infected in the field by conidia of the fungus *Neofabraea vagabunda.* A sub-cuticular stroma forms after about 72 hours, and lesions are first observable after 12 weeks of postharvest cold storage. Infections are enhanced in hydrated fruit with more open lenticels. Inoculum is released from sources in the canopy and the ground from September to April (spring to autumn). From May to August (late autumn to winter) more inoculum was splashed from the ground corresponding with observed fruit with sporulating lesions falling to the ground after harvest in April. More inoculum was collected in vertical 1 m traps (splash-meters) harvested monthly from April to November (late autumn, winter and early summer) than from December to March (summer to early autumn). More inoculum was released into rain-traps placed under pruning wounds and harvested monthly from April to July than other times during the season. Inoculum release was inversely related to temperature, more strongly for spores collected on splash-meters than from rain-traps.

Keywords: *Malus* x *domestica*, *Neofabraea alba*, *Phlyctema vagabunda*, infection, fruit susceptibility, lenticels, temperature, spore traps

OP-3

Incidence of postharvest diseases of carrot with special focus on tip rot

Belachew Asalf[1], Mirjam Halvorsrud[2], Berit Nordskog[1]

[1] Division of Biotechnology and Plant Health, Norwegian Institute of Bioeconomy Research (NIBIO), 1433 Aas, Norway. Email: belachew.asalf.tadesse@nibio.no
[2]Department of Plant and Environmental Sciences, Faculty of Biosciences, Norwegian University of Life Sciences (NMBU), 1432 Aas, Norway

Abstract

Carrot is the main field vegetable in Norway and stored in 0 -1 °C for up to 8 months. Due to this long storage period, postharvest diseases are problematic. Better knowledge on the causal agents of postharvest diseases can help producers apply appropriate control measures to reduce the carrot loss and waste. In collaboration with the Norwegian Agricultural Extension Service, we conducted survey to determine the occurrence of post-harvest diseases with special focus on symptoms categorized as tip rot of carrot. The study was conducted from 2019 to 2021 by collecting carrots from a total of seven commercial storages, representing four regions. From each storage, 400 carrots were randomly sampled, washed and sorted into categories representing different disease symptoms and healthy carrots. Representative samples from each category were further analyzed in NIBIO laboratory to identify the causal agent(s) and confirm the disease. Causal agent(s) were identified by symptom and sign description, microscopy and when necessary, by DNA sequencing. One or more pathogens were identified from each symptomatic carrot. The incidence of postharvest diseases varied among regions. Tip rot was the most abundant, followed by liquorice rot, cavity spot and gray mold. The symptom of tip rot includes light brown, brown and dark rot that start from the tip of the carrot tap root and progress to the main part of the carrot. Incidence of tip rot symptoms significantly varied among regions and among storages within the same region, ranging from 14.5% to 49%. Our results indicate that most of the post-harvest diseases of carrot are the result of latent infections that occur in the field, and stress during handling, storage, and processing operations. Hence, postharvest disease control measures should consider the pre- and postharvest predisposing factors of carrots for storage rot.

Keywords: Tip rot, carrot, postharvest, disease, pathogen

OP-4

Comparative genomics of the brown rot fungi *Monilinia fructicola*, *M. laxa* and *M. fructigena*

Rita Milvia De Miccolis Angelini[1†], Lucia Landi[2†], Celeste Raguseo[1], Stefania Pollastro[1], Gianfranco Romanazzi[2], Francesco Faretra[1]

[1] Department of Soil, Plant and Food Sciences, University of Bari Aldo Moro, 70126 Bari, Italy
[2] Department of Agricultural, Food and Environmental Sciences, Marche Polytechnic University, 60131 Ancona, Italy. Email: l.landi@univpm.it
[†] These authors contributed equally to this work

Abstract
Monilinia laxa (Aderh. & Ruhland) Honey, *Monilinia fructigena* (Pers.) Honey and *Monilinia fructicola* (G. Winter) Honey are *Ascomycetes* included in the *Sclerotiniaceae* family. They are responsible for blossom blight and brown rot, among the most important diseases on stone and pome fruits in the field as well as postharvest, which causes heavy yield losses and reduces shelf life. The impact of brown rot is remarkable, and the universal annual losses from disease outbreaks are severe. The complete draft genomes of *M. fructicola* strain Mfrc123, *M. laxa* Mlax316, and *M. fructigena* strain Mfrg269 have been recently reconstructed, and represent useful resources for investigations on diversity, population biology and plant-pathogen interactions. In this work, a comparative genomic analysis was performed on the three *Monilinia* assembled genomes. The whole genome investigation yielded new insights on the evolutionary history of the *Monilinia* genus within *Sclerotiniaceae*, and genomic differences among the three species were likely ascribed to their adaptation to different environments and hosts. This study improves knowledge on the biology of brown rot pathogens and their interactions with host plants.

Keywords: Brown rot, diversity, fungal genomes, phylogenesis, postharvest disease

OP-5

Aspergillus carbonarius lacking veA or pks genes involved in the OTA mycotoxin biosynthesis outcompete the parental strain during both *in vitro* and *in vivo* growth

Ana-Rosa Ballester, Belén Llobregat, Luis González-Candelas

Food Biotechnology Department, Institute of Agrochemistry and Food Technology (IATA-CSIC), Calle Catedrático Agustín Escardino 7, 46980 Paterna (Valencia) Spain. Email: ballesterar@iata.csic.es

Abstract

Aspergillus carbonarius is one of the main species responsible for toxin contamination of grapes and their derivatives, wine, coffee, and cocoa. Ochratoxin A (OTA), the major mycotoxin produced by this fungus, is a secondary metabolite classified as a possible carcinogen due to its high nephrotoxic character and the immunosuppressive effects that it triggers. The first enzyme in the OTA biosynthetic pathway is encoded by a polyketide synthase (*pks*) gene. It is known that growth, development, and secondary metabolite production are interconnected processes controlled by global regulatory factors in filamentous fungi. Besides that, these regulatory factors are encoded by genes that are generally located outside the gene clusters involved in the biosynthesis of secondary metabolites, such as the VELVET complex, including the *veA* gene. The baseline hypothesis of this work is that different fungal strain can compete for the nutrients and space during the infection of their hosts, and safer non-mycotoxigenic strains could outcompete mycotoxigenic strains during colonization. In this study, we utilized knockout mutants in the *pks* and *veA* genes of *A. carbonarius* and studied the capacity of these strains to outcompete mycotoxigenic strains. We will show that the non-mycotoxigenic strains can outcompete the parental strain during both *in vitro* growth and infection of grapes. In addition, the establishment of the non-mycotoxigenic producer reduced the amount of OTA. Although a non-mycotoxigenic strain can still infect the fruits, the risk of mycotoxin contamination of the fruits will be reduced and the final produce will be safer for human and animal intake.

Funding: JAEINT_19_01896 (CSIC), FPI-MICINN PRE2019-089326, RYC-2017-22009 (MICINN/AEI/FSE, UE), AGL2017-88120-R (MCIU/AEI/FEDER, UE), and RTI2018-093392-A-I00 (AEI/FEDER, UE) programs.

Keywords: Gene editing, ochratoxin A, postharvest pathology

OP-6

Preliminary epidemiological features of kiwifruit skin pitting agent: *Cadophora luteo-olivacea* (J.F.H. Beyma) T.C. Harr. & McNew)

Alessandra Di Francesco[1,2], Fiorella Neri[1], Elena Baraldi[1], Ugo Palara[3], Paolo Bertolini[1]

[1] Department of Agricultural Sciences, University of Bologna, 40057, Bologna, Italy. Email: alessandra.difrancesco@uniud.it
[2] Department of Agricultural, Food, Environmental and Animal Sciences, University of Udine, 33100, Udine, Italy
[3] Agrintesa, Agrintesa Società Cooperativa Agricola, Via G. Galilei 15, 48018, Faenza, Italy

Abstract

During last years, skin pitting symptoms in Emilia-Romagna Region packaging houses, caused by *Cadophora luteo-olivacea*, were detected. Hence, there is need to learn about the pathogenicity of this fungus, able to afflict mainly kiwifruits (crop of considerable economic importance) during the postharvest phase. The study was conducted by linking different experiments conducted *in vitro*, *in vivo*, and kiwifruit orchards. The first goals pursued were to conduct a deep analysis on the virulence of *C. luteo-olivacea* in different growth conditions: temperature and kiwifruit ripeness. *In vivo* assays were conducted by spray pathogen inoculation on kiwifruit belonging to different ripening degrees and stored for 5 months at 0 °C. In the field, over two years of experiments were conducted to verify at which kiwifruit phenological phase the pathogen began its latency on fruit. Kiwifruits were bagged on plants at four different ripening degrees, starting from July to October, all collected in November and stored for 5 months at 0 °C in normal refrigeration. This experiment aimed to arrange preventative measures to reduce the risk of kiwifruit infections during the growing season and plan strategic field and storage management. Results showed a higher ability of the pathogen to grow at 20 °C and under-ripe kiwifruits seemed to enhance its aggressiveness during storage. Field experiment results displayed that kiwifruit bagged in July were less susceptible to skinning pitting symptoms after storage (5%) concerning the other subsequent months (respectively, 20, 25, and 30%). Afterward, through these results, we can suppose that field and storage management strategies should be strictly connected to control the pathogen development.

Keywords: Latent infection, fruit ripeness, epidemiology, bagged fruit, storage

OP-7

Strains of *Penicilium expansum* exhibiting Multidrug Resistance phenotype show an overexpression pattern of efflux transporter genes and genes of patulin biosynthesis pathway

George Karaoglanidis, Panagiota Ntasiou, Anastasios Samaras

Laboratory of Plant Pathology, Faculty of Agriculture, Forestry and Natura, Aristotle University, Thessaloniki, Greece. Email: gkarao@agro.auth.gr

Abstract

Penicillium expansum is the most common apple fruit postharvest spoilage agent causing a disease known as Blue Mold. Losses are both quantitative and qualitative because of the mycotoxin patulin production ability of *P. expansum*. Disease control is primarily based on fungicide use. However, development of resistance to fungicides hampers the success of this control method. This study was initiated aiming to test the hypothesis that the multidrug resistance (MDR) phenotype, observed in several fungal strains, is associated with overexpression of efflux transporter genes. In total, 264 isolates were tested for sensitivity to 9 fungicides and almost 5% of them showed an MDR phenotype. The absence of SNPs (Single Nucleotide Polymorphisms) in target genes, led to a RNAseq approach to investigate alternative resistance mechanisms. Different expression levels of efflux transporters were observed in the MDR strains. The induction of MFS and ABC transporter genes was observed both in the presence and absence of fungicide exposure. Isolates with MDR phenotype exhibited higher ability to produce patulin both *in vitro* and *in vivo*. At the same time, a qPCR analysis showed that MDR strains presented a higher expression of genes encoding patulin biosynthesis. This correlation in addition with the low control efficacy of MDR strains, could be an important key concern for the post-harvest control strategies of *P. expansum*. The above-mentioned data represent the first report of MDR in *P. expansum* associated with overexpression of drug efflux transporters and contribute to our knowledge in the mechanisms associated with fungicide resistance development in this fungal species.

This research is co-financed by Greece and the European Union (European Social Fund-ESF) through the Operational Programme "Human Resources Development, Education and Lifelong Learning 2014–2020" in the context of the project "Resistance of Penicillium expansum populations to fungicides and transcriptomic investigation of the multidrug resistance mechanism (MDR)" (MIS 5004852).

Keywords: *Penicillium expansum*, multidrug resistance, patulin, fitness, apples

OP-8

Unravelling the impact of conventional and organic farming system on Black Aspergilli population structure, mycotoxigenic capacity and mycotoxin contamination assessment in Greek wines, using a new Q-TOF MS-MS detection method

Stefanos Testempasis[1], Natalie Kamou[2], Emmanouil Papadakis[2], Urania Menkissoglou[2], George Karaoglanidis[1]

[1] Plant Pathology Laboratory, Faculty of Agriculture, Forestry and Natural Environment, Aristotle University of Thessaloniki, 54124, Thessaloniki, Greece. Email: testempasis@gmail.com
[2] Pesticide Science laboratory, Faculty of Agriculture, Forestry and Natural Environment, Aristotle University of Thessaloniki, 54124, Thessaloniki, Greece

Abstract
Aspergillus bunch rot, caused by several mycotoxigenic species of Black Aspergilli section *Nigri* is one of the most severe pre- as well as post-harvest diseases of grapevines, while contaminated grape products and derivatives with *Aspergillus* mycotoxins may have an important impact on consumers health. During a 2-year survey, the impact of conventional and organic farming systems on Black Aspergilli population structure in Greek vineyards was thoroughly investigated. In total, 300 isolates of *Aspergillus* spp. Were identified by amplicon sequencing. Four different *Aspergillus* species (*A. tubingensis, A. uvarum, A. carbonarius* and *A. niger)* were identified as the casual agents of the disease in the sampled vineyards. *A. uvarum* and *A. tubingensis* were identified as the dominant species in the 2018 and 2019 samplings, respectively. During both sampling years, higher frequencies of *A. tubingensis* and *A. uvarum* were found in the organic and conventional vineyards, respectively. *In vitro* production of ochratoxin A and fumonisin B_2, B_3 and B_4 was evaluated in two selective media. The analysis revealed a low frequency of mycotoxigenic isolates, mainly originated from conventional vineyards. Additionally, *A. carbonarious* was identified as the main OTA producer, whereas *A. niger* was the leading producer of FB_2, FB_4, and FB_6. Overall, 74 organically and conventionally produced wines were analyzed using a new QTOF-MS-MS analytical method developed to detect and quantify various mycotoxins (OTA, FB_1, FB_2 FB_3, AOH, AME, CIT) using a modified QuEChERS extraction protocol. Interestingly, a low frequency of mycotoxin-contaminated wines was detected. However, fumonisins were identified as the main mycotoxins in Greek wines compared to OTA which was found in only one sample. This is the first study deciphering the impact of conventional and organic farming systems on *Aspergillus* section *Nigri* species in Greek vineyards, suggesting that cropping system may affect the species composition within the vineyard.

Keywords: *Aspergillus* spp., farming system, fumonisin, grapevine, mycotoxins, ochratoxin A

OP-9

Alternaria spp. causing postharvest decay on apple fruit in Nigde province, Turkey

Keziban Sinem Tulukoglu Kunt[1], Sibel Dervis[2], Mustafa Ozden[1]

[1] Department of Plant Production and Technologies, Nigde Omer Halisdemir University, 51240, Nigde, Turkey. Email: ksinemtulukoglu@gmail.com
[2] Vocational Higher School of Kızıltepe, Mardin Artuklu University, 47400, Mardin, Turkey

Abstract
Postharvest rots caused by *Alternaria* spp. result from infections occurring in the apple orchard at or before harvest and these may remain quiescent during the growing phase and only result in decay during postharvest cold storage. Therefore, the objective of this study was to identify and characterize *Alternaria* spp. associated with apple black spot and/ or decay during cold storage in Nigde, Turkey. Isolates of *Alternaria* spp. were obtained from apple fruit (cvs Fuji, Golden Delicious, Granny Smith, Red Delicious, and Starking Delicious) with dark, dry, spongy lesions. The symptomatic fruits were sampled from 18 commercial cold storages in the Nigde Province, Turkey, during the 2020/21 storage period. Decayed fruits were transferred to the laboratory for isolation of the fungi from the lesions. In total, 75 *Alternaria* isolates were characterized morphologically and were differentiated into 5 phenotypic groups based on their colony morphology, and characteristics of their conidiophores and conidia. At least 5 representative isolates were randomly chosen from each group for the pathogenicity tests. All *Alternaria* spp. isolates caused round, dry, dark, spongy lesions on/in the inoculated fruits and re-isolates from the inoculated apples of each phenotypic groups were similar to the initial isolates of each group in morphological characteristics. Molecular characterization of isolates is in progress. Since mycotoxin produced by *Alternaria* spp. in fruits is of unavoidable risk to human health, special care should be given in regards to the need to reduce widespread postharvest losses caused by *Alternaria* spp. in the cold storages of Niğde, which is the most important apple producer province of the country.

Keywords: Cold storage, fruit rot, *Malus domestica*, fungal disease

OP-10

Glycosylated flavonoids: fruit's concealed antifungal arsenal

Pradeep Kumar Sudheeran, Oleg Feygenberg, Dalia Maurer, Noam Alkan

Department of Postharvest Science, Volcani Institute, ARO, HaMaccabim Road 68, Rishon LeZion, 7505001, Israel. Email: noamal@agri.gov.il

Abstract

Mango (*Mangifera indica* L.) fruit that was exposed to sunlight at the orchard accumulate anthocyanin and flavonols and develop red skin color. Some of those flavonoids and anthocyanins are known to have antifungal activity. Therefore, red mango fruits are more resistant to the pathogenic fungus, including *Colletotrichum gloeosporioides*. The objective of this study was to identify the different anthocyanin and flavonols in 'Shelly' mango peel and evaluate their antifungal activity against *C. gloeosporioides.* Organic extraction of red fruit peel showed increased inhibition of conidia germination and hyphal growth in comparison to extract from green mango peel. Analysis of un-hydrolyzed samples showed that the anthocyanin peaks were glucoside derivatives of cyanidin and methylcyanidin, and the flavonol peaks were glucoside derivatives of quercetin and kaempferol. Thus, all the identified flavonoids were glycosylated. Transcriptome analysis of host-pathogen interaction of mango and *C. gloeosporioides* showed an increase of large sets of β-glucosidase genes related to fungal pathogenicity and host defense response during decay development. When the peel extract from both red and green fruit was treated with β-glucosidase, the flavonoids aglycones inhibited *C. gloeosporioides* hyphal growth and conidia germination much more than its glycosylated form. Similarly, β-glucosidase treatments on the peel extract released a large amount of antifungal volatiles, which further inhibited the fungal growth. Indeed, peel extract treated with β -glucosidase resulted in decay inhibition of various pathogenic fungi on several fruits. To summaries, the results of this study indicate that glycosylated anthocyanin and flavonoids are the fruit hidden arsenal against the fungal pathogen. When the fungal pathogen attack and secrete β-glucosidase, it degrades the flavonoids to its aglycones form, which are much more toxic to the fungi. Thus, glycosylated flavonoids play an essential role in fruit defense mechanism towards fungal pathogens and control of postharvest decay. These results further suggest that peel extract treated with β-glucosidase could control postharvest decay and be a new alternative to chemical fungicide.

Keywords: Glycosylated flavonoids, fruit's concealed antifungal arsenal, antifungal activity, *Colletotrichum gloeosporioides*, β-glucosidase, glycosylated flavonoid, kaempferol quercetin

OP-11

Fungal microbiome shifts of avocado fruit from flowering to the ready-to-eat stage

Malick Bill, Francois Viljoen, Lizyben Chidamba, Lise Korsten

Department of Plant and Soil Sciences, Natural and Agricultural Sciences, University of Pretoria, 0002, Hatfield, Pretoria, South Africa. Email: malickbill@gmail.com

Abstract

Mycobiomes are directly affected by pre- and postharvest practices that may impact fruit quality. The fungal diversity and composition associated with 'Hass' avocados from flowering to the ready-to-eat stage was investigated using Next-generation (Illumina) sequencing of the internal transcribed spacer (ITS1) during the 2017/18 season. The study aimed at understanding epiphytic (fructoplane) and endophytic (stem-end pulp) microbiome dynamics with particular emphasis on the presence of the pathogenic and beneficial fungal genera. A total of 1374325 ITS sequences were generated in this study. Sequences belonging to the *Colletotrichum* (*Colletotrichum gloeosporioides*), *Alternaria* (*Alternaria alternata*) and *Epicoccum* (*Epicoccum nigrum*) genera were detected as the most dominant postharvest decay causing fungal genera throughout the study period. Other decay causing genera detected included *Fusarium* (*Fusarium* sp.), Mucor (*Mucor racemosus*) and *Botryosphaeria* (*Botryosphaeria* sp.). Meanwhile, *Aureobasidium* (*Aureobasidium pullulans*) was detected as the dominant potential beneficial fungal genus. Postharvest interventions such as the prochloraz dip treatment had a non-targeted effect on the presence of *Aureobasidium pullulans* populations both on the avocado fructoplane and in the stem-end pulp. Similarly, the prochloraz dip treatment resulted in a decline in fungal richness (ACE index). The current study provides important baseline data for further exploration of microbial population shifts in avocado fruit as a foundation in the development of effective anthracnose and stem-end rot in avocados.

Keywords: Fruit mycobiome, phytopathogenic fungi, endophyte, postharvest diseases

OP-12

Impact of storage technologies on epiphytic blemishes of apple fruit

Angelo Zanella[1], Ines Ebner[1], Séverine Gabioud Rebeaud[2], Sabine Öttl[3], Yazmid Reyes-Dominguez[4]

[1] Institute for Mountain Agriculture and Food technology, Research Group Storage and Postharvest Biology, Research Centre Laimburg, 39040 Ora, Bolzano, Italy. Email: angelo.zanella@laimburg.it
[2] Research Division Plant Production Systems, Agroscope Research Center, 1964 Conthey, Switzerland
[3] Institute for Plant Health, Research Group Phytopathology, Research Centre Laimburg, 39040 Ora, Bolzano, Italy
[4] Institute for Plant Health, Research Group Virology and Diagnostics, Research Centre Laimburg, 39040 Ora, Bolzano, Italy

Abstract
Epiphytic fungi that cause symptoms such as sooty blotch, white haze or flyspeck provoke relevant blemishes especially in organic apples in South Tyrol (North Italy). By microbiological isolation and direct sequencing of the organisms found on the epidermis of the apple, it has been possible to identify so far more than 30 fungal species. The most frequently detected genera include *Aureobasidium*, *Phoma*, *Fusarium* and *Cladosporium*. Satisfactory defense against this fungal complex has often not been possible in orchards because of the limited availability of fungicides, and incidence increases due to significant application restrictions, the enhanced occurrence of honeydew-excreting insects and agronomic practices such as foliar nutrition or hail nets. Moreover, the fungal complex may also proliferate during storage. Therefore, the influence of different storage technologies to prevent such epiphyte development after harvest was studied: the modification of air atmosphere during storage in ultra low oxygen (CA-ULO), differences in humidity, ionization of the atmosphere, ozone enrichment of the atmosphere at different intervals and concentration. The time of harvest, or respective ripening stage, was taken into account. The degree of humidity modulated the occurrence of symptoms and indicated the importance of the coordinated management of the storage cold rooms. Fruit quality could be influenced by this. Ionization and ozone enrichment showed an increasing influence on the development of epiphytes with different expressions of symptoms. Greasiness of cuticle has been observed as a side effect, the causes of which need to be investigated in more detail in order not to be an obstacle to commercialization. In addition, there are still numerous questions to be clarified for the implementation of the experimental results in practical scale.

Keywords: *Malus x domestica*, apple fruit, post-harvest disease, sooty blotch, white haze, CA storage, air ionization, ozone

OP-13

Identification of *Monilinia fructicola* effectors that contribute to peach leaf infection

Laura Vilanova Torren[1,2], Claudio A. Valero-Jiménez[2], Rosario Torres[1], Jan A.L. van Kan[2]

[1] Postharvest Programme, Institute of Agrifood Research and Technology (IRTA), 25003, Lleida, Spain. Email: laura.vilanova@irta.cat
[2] Laboratory of Phytopathology, Wageningen University, 6708 PB, Wageningen, The Netherlands

Abstract

Monilinia fructicola is a fungus responsible for brown rot disease in stone fruit and is endemic in North America, Australia and Japan. In Europe, it was considered a quarantine pathogen by EPPO until it spread across the continent. Nowadays *M. fructicola* and *M. laxa* co-occur in European orchards although *M. fructicola* causes more important losses due to its dissemination capacity. *M. fructicola* and other *Sclerotiniaceae* species, are necrotrophic fungal pathogens that need to kill host cells and degrade the plant tissue to develop the infection process. In this study, we identified *M. fructicola* effector genes that are highly expressed during infection of stone fruit leaves and participate in the induction of cell death. RNA-Seq was used to detect differentially-expressed genes of *M. fructicola* at different time points when compared to *in vitro* controls. The time points were selected according to infection stages: i) spore germination; ii) surface penetration; iii) primary lesion development; iv) expansion of lesions, respectively. Expression patterns of all 134 putative effector genes were distributed in 5 different clusters. Genes of two clusters showed highest expression at 18 and 24 hpi while genes in another cluster displayed continuous high expression levels. Based on expression profiles and on homology with other *Monilinia* spp., we selected 16 *M. fructicola* effectors for subsequent experiments. *M. fructicola* effector proteins can in the future be exploited to screen stone fruit cultivars for resistance breeding.

This project received funding from the European Union's Horizon 2020 programme (grant 741964); the postdoctoral fellowships programme Beatriu de Pinós, funded by the Secretary of Universities and Research (Government of Catalonia) and by the Horizon 2020 programme of the European Union (MSCA grant 801370); the Spanish Government (national project PID2020-115702RB-C22 from the Ministry of Science and Innovation).

Keywords: Necrosis, effectors, virulence, breeding, RNA-Seq

OP-14

Natamycin, a new natural compound for postharvest: Opportunities and challenges.

Geoffroy de Chabot-Tramecourt, Wendy Schotsmans

Janssen PMP (Preservation and Material Protection), Janssen Pharmaceutica NV, Turnhoutseweg 30, 2340 Beerse, Belgium. Email: gdchabot@its.jnj.com

Abstract

Natamycin (also known as pimaricin) is a natural fungicide, firstly isolated in 1955 from a fermentation broth of a *Streptomyces natalensis* cell culture. Today, Natamycin is commonly used in the food industry and registered as Food Additive in several territories in the world (E 235). Natamycin has the potential to be an effective tool to control postharvest pathogens of citrus and other fruits. Recently, Natamycin was registered by EPA in the US as postharvest natural fungicide (biopesticide registration). The use of Natamycin-based formulations, including Uniguard™, presents a lot of technical advantages but also several barriers. The current presentation will describe in detail why natural fungicides in general and Natamycin in particular, are not always easy to apply in postharvest. Firstly, the *in vitro* and *in vivo* efficacy of this compound on different postharvest pathogens, including wild-type and resistant *Penicillium* spp. will be discussed. Also, the compatibility of Natamycin-based formulations in commonly used postharvest practices will be addressed, as well as the possible degradation of the active substance in low and high pH environments. Finally, the regulatory landscape related to the use of Natamycin at global level will be presented.

Keywords: Pesticide, natamycin, biopesticide, alternative technologies, innovation, research, regulatory

OP-15

Phenylalanine: A new inducer improve fruit quality and resistance to postharvest pathogens and chilling injury

Manish Kumar Patel, Dalia Maurer, Oleg Feygenberg, Noam Alkan

Department of Postharvest Science, Agricultural Research Organization ARO, Volcani Institute, Rishon LeZion 7505001, Israel. Email: patelm1402@gmail.com

Abstract

More than one-third of harvested fruits and vegetables are lost. Major part of it is due to decay caused by fungal pathogen. The restrictions on fungicides that control those fungal pathogens, call for economical, safe and eco-friendly alternatives to control the postharvest decay. Fruit's natural resistance depends majorly on flavonoids and anthocyanins synthesized from the phenylpropanoid pathway, which have antioxidant and anti-fungal activity. In this work, we hypothesized that exogenous application of phenylalanine could induce the fruits natural defense response, improve fruit quality and reduce decay. Indeed, postharvest application of phenylalanine to mango and avocado fruit reduced fruits decay caused by *Colletotrichum gloeosporioides*, *Alternaria alternate* or *Lasiodiplodia theobromae*. Similarly, postharvest application of phenylalanine to citrus fruit reduced fruit green mold caused by *Penicillium digitatum*. Interestingly, an immediate inoculation of *P. digitatum* after phenylalanine application did not improve fruit resistance, whereas inoculation performed 2 days after the phenylalanine treatment induced tolerance to *P. digitatum*. Five hours after the treatment, no phenylalanine residue was detected in the fruit, probably due to rapid metabolism. Additionally, preharvest application of phenylalanine to strawberries, mangoes, and citrus lead to reduction of natural postharvest decay. Subsequently, phenylalanine treatment reduces chilling injury and maintain fruit quality in mango fruit during storage at sub-optimal temperature. Interestingly, phenylalanine also improves the fruits aroma, and increase the soluble sugars. To conclude, in the present study we characterized a new inducer of fruit defense response-phenylalanine. Preharvest or postharvest application of phenylalanine to various fruits activates the fruits defense responses and led to the inhibition of postharvest decay caused by various fungal pathogens. This novel application of the amino acid, phenylalanine, could become an eco-friendly and healthy alternative to fungicides.

Keywords: Phenylalanine, induced resistance, preharvest application, postharvest application, fungal pathogen, chilling injury, quality improvement

OP-16

Nano-clay particles loaded with double-strand RNA reduces *Botrytis cinerea* colonization and gray-mold in harvested fruits

Danielle Duanis-Assaf, Ortal Galsurker, Oleg Feygenberg, Dalia Maurer, Noam Alkan

Department of Postharvest Science, Agricultural Research Organization, Volcani Institute, 7505001, Rishon LeZion, Israel. Email: danielle.assaf@mail.huji.ac.il

Abstract

Postharvest fruit and vegetable loss is estimated at more than 40%. Pathogenic fungi cause major part of this loss. During storage, along ripening, the fruit becomes more susceptible to fungal pathogen and the development of postharvest disease. Currently, the common treatment against postharvest diseases is fungicides. However, there is a growing concern for their harmful influences on the environment and human health. Therefore, there is a need to develop new strategies to control postharvest pathogens. Recently, it was demonstrated that *Botrytis cinerea,* a major postharvest pathogen, naturally uptakes small double-strand RNA (dsRNA) molecules from the host plant, which down-regulate genes through the RNA interference (RNAi) system. In this study, we aimed to develop a dsRNA for postharvest application to reduce fungal colonization and fruit rot. We synthesized dsRNA consisting of three genes involved in the ergosterol biosynthesis pathway (essential genes). Due to the low stability of dsRNA, it was loaded on layered-double hydroxide (LDH) nano-clay, which should protect the dsRNA from degradation and serve as a slow-release device. Our results show that the growing part of *B. cinerea* germination tube and hyphae can uptake dsRNA when applied alone or loaded in LDH. The dsRNA decreased fungal growth and germination both *in vitro* and *in vivo* in various fruits including grapes, strawberry, cherry, bell-pepper, and more. Addition of external ergosterol restores the phenotype, which indicates that the reduction in germination and fungal growth is due to RNAi activation. These results also support the down-regulation of all three related genes after dsRNA treatment. The dsRNA-LDH complex enables reduction in the dsRNA concentration. Notably, when combined with dsRNA, the required concentration of fungicide treatments was reduced by 100-fold. Overall, our results suggest that the combination of dsRNA and LDH may serve as a safe alternative to the postharvest application of fungicides.

Keywords: *Botrytis cinerea*, dsRNA, LDH, postharvest decay, postharvest application, ergosterol

OP-17

Microbial extracts as natural preparations to control postharvest rots of fresh fruits

Valentina T. Librizzi[1], Nataly Barger[2], Sonia Pangallo[1], Maria G. Li Destri Nicosia[1], Giovanni E. Agosteo[1], Imen Belgacem[1], Ahmed Abdelfattah[3], Tal Luzzatto-Knaan[2], Leonardo Schena[1]

[1] Department of Agriculture, "Mediterranea" University of Reggio Calabria, Localy Feo di Vito, 89122, Reggio Calabria, Italy. Email: lschena@unirc.it
[2] Department of Marine Biology, Leon H. Char School of Marine Sciences, University of Haifa, Haifa 3498838, Israel
[3] Institute of Environmental Biotechnology, Graz University of Technology, A-8010 Graz Petersgasse, Austria

Abstract
Microorganisms represent a rich source of biologically active substances including antifungal compounds that can potentially be used as alternative methods to control postharvest diseases. In this study, a number of bacterial strains producing and releasing antifungal compounds were identified from natural forest soils and utilized to obtain antifungal preparations. Selected bacteria were associated to 4 different 16S genotypes clustering within the genus *Pseudomonas* spp. Alcoholic extracts from these bacteria proved a significant antifungal activity by inhibiting the mycelial growth of typical postharvest pathogens including *Botrytis cinerea, Penicillium digitatum, P. italicum P. expansum, Monilinia fructicola*, and *Colletrotrichum acutatum*. The same extracts were particularly effective in reducing the incidence of rots on different artificially inoculated fruits such as citrus, apricots, sweet cherries, table grape, and tomatoes. Furthermore, they proved effective under semi-commercial conditions by reducing natural rots on sweet cherries subjected to cold storage and shelf-life. In addition to the direct antifungal activity, the induction of resistance in treated host tissues was also demonstrated. According to metabolomics analyses, 521 target features were detected within the extracts of 3 selected bacteria. Although most of them were not annotated, some common *Pseudomonas* membrane structural lipids as well as natural products such as phenazine and orfamide analogs, known to have some antimicrobial and antifungal activity, were identified. Additional investigations are needed to correlate the composition of extracts with their biological activity and identify putative active ingredients.

Keywords: *Pseudomonas* spp., alcoholic extracts, control of fungal diseases, antimicrobial activity, metabolomics analyses

OP-18

Novel strategies to enable breeding for increased resistance to postharvest pathogens

Suzan Gabriels[1], Paul Arens[1], Yuling Bai[1], Arnaud Bovy[1], Vivianne Vleeshouwers[1], Richard Visser[1], Ernst Woltering[2]

[1] Department of Plant Breeding, Wageningen University & Research, 6708 PB Wageningen, The Netherlands. Email: suzan.gabriels@wur.nl
[2] Department Wageningen Food & Biobased Research, Wageningen University & Research, 6708 PB Wageningen, The Netherlands

Abstract
Within Wageningen University and Research, we aim to exploit the biodiversity in *Capsicum* (pepper) and *Rosaceae* (strawberry and roses), to unravel the genetic mechanism of resistance against respectively *Phytophthora capsici* and *Botrytis cinerea.* Both these pathogens cause severe disease symptoms in greenhouses, open-field and even upon postharvest transport or storage. There is a need for more resistant varieties to reduce losses and decrease chemical use in production as well as in postharvest storage and distribution. Besides defense mechanisms which are based on presence of multiple R genes, a novel strategy to obtain resistance is observed in varieties with mutations in plant S (susceptibility) genes. Functional mutations in S genes turn a host plant into a non-host, leading to broad spectrum resistance to all pathogen species requiring presence of that specific S gene. Within a consortium of plant breeding partners, we aim to identify putative S genes in our target crops. A number of S genes required for pathogenicity of *Phytophthora* and *Botrytis* have already been identified in *Arabidopsis thaliana* and in several crops like lettuce, potato and tomato. We aim to identify the orthologs of these known S genes in our target crops. Allele mining will be used to investigate presence of S gene mutants among the core collections available at Wageningen Plant Breeding and among interesting sources from the participating companies. Increased knowledge of the pepper - *P. capsici* and *Rosaceae-Botrytis* interactions might also be useful for breeding for resistance in other complex host-pathogen systems.

Keywords: Disease resistance, susceptibility genes, allele mining, *Phytophthora*, *Botrytis*

OP-19

Sanitization System in Horticultural sector

Luca Buglia

Fruit Control Equipments, via R. Luxemburg 55, 20085 Locate di Triulzi, Italy. Email: buglia@fruitcontrol.it

Abstract

Environmental sanitation has now become a priority in the food sector. Fruit Control, historically recognized internationally, as a leader in the controlled atmosphere sector, has also invested in the sanitation sector with the use of ionizers for the removal of microorganisms in agri-food environments. The presentation reports results related to this technology on different products and both experimental and real situations, also in fruit and vegetable distribution platforms. In particular, results are reported on kiwifruit and in a storage and distribution warehouse.

Keywords: Sanitization, sanitation, fruit control, ionization, fruit storage

OP-20

Demonstration of efficacy of a *Pythium oligandrum* product postharvest treatment against fruit rot in apples

Petr Rubák[1], Edyta Zajkowska[2]

[1] Biopreparáty, spol. s r.o., Tylišovská 772/1, 160 00, Praha 6, Czech Republic. Email: rubak@biopreparaty.eu
[2] Bio Agris ul. Dylewska 20b, 03-011 Warszawa, Poland

Abstract
Pythium oligandrum is a non-pathogenic soil-inhabiting oomycete with strong mycoparasitic abilities colonizing the root system of many crops. The final formulation containing this microorganism has been developed, marketed and sold under the trade name Polyversum by a Czech company Biopreparaty, spol. s r.o. The method of application using fogging machines has been developed by a Polish partner company Bioagris. The efficacy on postharvest rots of apples was demonstrated in a trial lasting two storage seasons on two varieties of apples, performed in commercial storage chambers. A reduction in fruit rot after *Pythium oligandrum* formulation treatment compared to untreated samples was proven in both, the reduced temperature cold storage variant and the ULO variant (nitrogen atmosphere with ripening inhibitors).

Keywords: *Pythium oligandrum*, post-harvest treatment, apples, microbiological plant protection product, PPP

OP-21

Biocontrol strategies in the management of *Cadophora luteo-olivacea*, skin-pitting agent of kiwifruit

Farwa Jabeen, Alessandra Di Francesco, Abderraouf Sadallah, Paolo Ermacora, Marta Martini

Department of Agricultural, Food, Environmental and Animal Sciences, University of Udine, 33100, Udine, Italy. Email: jabeen.farwa@spes.uniud.it

Abstract

Skin-pitting causes great economic losses as the symptoms appear on fruits only after 3-4 months of cold storage. Nowadays, very few synthetic active ingredients are allowed in postharvest, also because of the related residue problems; for this reason, the goal of the present study was to search for alternative strategies to control skin-pitting disease. Thus, the efficacy of bacterial strains to be used as biocontrol agents (BCAs) was tested by *in vitro* and *in vivo* assays against *Cadophora luteo-olivacea*, the causal agent of postharvest skin-pitting disease of kiwifruit (*Actinidia deliciosa* (A. Chev.) C.F. Liang & A.R. Ferguson *cv.* Hayward). *C. luteo-olivacea* was isolated from symptomatic kiwifruits during a survey in Friuli Venezia Giulia Region (Italy) in 2020 and identified by morphological and molecular analysis. *Bacillus* and *Pseudomonas* spp. BCAs strains efficacy was evaluated by *in vitro* assays against the pathogen mycelial growth, by testing their mechanisms of action. The antagonists were also tested for their ability to control *C. luteo-olivacea* infection *in vivo* on kiwifruit during the storage, by artificial inoculation. BCAs were applied both as a preventive and curative treatment against the fungal pathogen. Fruits were stored at 0 °C and 90% RH for 3 months. *In vitro* results showed that the strain belonging to *B. amyloliquefaciens* species was the most effective against fungal mycelial growth by all the tested antagonistic strategies. From preliminary results of the *in vivo* assay, the antagonists appear promising in reducing the incidence of skin-pitting disease. Thus, this study may represent a valid and sustainable alternative approach to control *C. luteo-olivacea* during the storage phase.

Keywords: Biocontrol agents, latent infection, mechanisms of action, storage phase, postharvest disease management

OP-22

Effect of tobacco leaves (*Nicotiana tabacum*) on the weevil (*Acanthoscelides obtectus*) of common bean (*Phaseolus vulgaris*) in western region, Cameroon

Henri Grisseur Djoukeng[1], Yannick Frank Tanku Tedjon[1], Alphonse Azebaze[2]

[1] Department of Rural Engineering, University of Dschang, B.P. 222, Dschang, Cameroon. Email: hgdjoukeng@gmail.com
[2] Cercle international pour la promotion de la création (CIPCRE), Bafoussam, Cameroon

Abstract
A questionnaire survey was administered to identify the bean conservation methods used by farmers in the Hauts-Plateaux division, in western Cameroon. To reduce post-harvest losses of common bean (*Phaseolus vulgaris*) in the study area, a six-month study was carried out with red and black beans. Vegetable powder of tobacco leaves (*Nicotiana tabacum*) was produced to be tested against the bean weevil (*Acanthoscelides obtectus*). Tobacco leaves were dried to 13.5% moisture content, crushed and sieved to obtain a powder at pH 5.63. This powder and two other synthetic insecticidal powders (Antouka and Protect DP) based on permethrin were incorporated at a dose of 1 g kg^{-1} in batches of beans. The coated seeds were placed in 125 mL polyethylene boxes containing 100 seeds each, then stored for 6 months in a room at a temperature between 15 and 27 °C. The experimental set-up applied for each variety was the random plan comprising of four replicates and four treatments (Control without treatment, Tobacco, Protect DP, Antouka). This device made it possible to make observations on the perforation of seeds, the emergence of weevils and their mortality. Based on the questionnaire survey, the results showed that 41% of farmers use synthetic insecticides, 36% do not use any substance, 14% wood ash, 9% fir leaves. This study showed that tobacco powder significantly reduced the puncture of beans by weevils, indicating the importance of alternatives means for pest control. It was also emerged from this study that the black bean is more resistant to weevils than the red one.

Keywords: Postharvest, pest, insecticidal effect, Bafoussam

OP-23

Poinsettia cuttings increase resistance to *Botrytis cinerea* infection over time in propagation

Melissa Munoz, Paul Millar, James Faust, Guido Schnabel

Department of Plant and Environmental Sciences, Clemson University, 29630, Clemson, USA. Email: munoz@clemson.edu

Abstract

Poinsettias (*Euphorbia pulcherrima*) are one of the most valued potted plants with an annual wholesale value exceeding $250 million in the U.S. Commercially production begins with the propagation of unrooted cuttings that are harvested from stock plants. Unrooted cuttings are produced in Central America and shipped to the U.S. During propagation, Botrytis blight caused by the *Botrytis cinerea* can reduce the quality and viability of poinsettia cuttings, leading to leaf loss and collapse of the tissue. Freshly harvested cuttings appear to be more prone to the development of Botrytis blight; however, there are no data to sustain this observation. Our objective was to evaluate if the age of poinsettia cuttings affects their susceptibility to Botrytis blight. Two experiments were conducted with three repetitions over time. During the first experiment, poinsettia cuttings were harvested 0, 2, and 4 d before inoculation with a *Botrytis cinerea* (10^4 spores mL^{-1}). For the second experiment, cuttings were harvested 0, 3, 6, and 9 d before inoculation. For both experiments, the cuttings were placed in humid chambers following inoculation, and Botrytis blight development was assessed over 15 d. Non-inoculated cuttings of each treatment were placed in the humid chambers simultaneously with the inoculated sets to evaluate natural disease pressure. Fifteen days after inoculation 2- and 4-d-old cuttings showed significantly less severity than the 0-day-old cuttings for both inoculated and non-inoculated cuttings. Similarly, 6- and 9-day-old inoculated cuttings performed significantly better than 0- and 3-d-old inoculated cuttings. For non-inoculated cuttings, Botrytis blight severity was significantly reduced even for 3-d-old cuttings compared to 0-d-old cuttings. Our results indicate that the age of poinsettia cuttings is linked to the susceptibility to Botrytis blight severity, and cuttings are most susceptible to Botrytis infection immediately following harvest. Further investigation is required to elucidate physiological and molecular mechanisms behind this response.

Keywords: Botrytis blight, poinsettia, cuttings, propagation, cutting age

OP-24

Evaluation of hot water and GRAS salt solutions for the control of postharvest gray and green molds of pomegranate fruit

Lluís Palou, Verònica Taberner

Laboratory of Pathology, Postharvest Technology Center (CTP), Valencian Institute of Agrarian Research (IVIA), 46113 Montcada, Valencia, Spain. Email: palou_llu@gva.es

Abstract

Gray and green molds, caused by the fungi *Botrytis cinerea* and *Penicillium* spp., respectively, are among the most important postharvest diseases of pomegranate fruit in Spain. Although the synthetic fungicide fludioxonil is allowed for postharvest use since 2019, disease control methods alternative to agrochemicals are preferred, especially in pomegranate export markets, due to health and environmental issues associated with chemical residues. In this work, the disease control ability of dips in hot water (20, 40, 50, 55, 60, 65, 70, and 75 ºC) or aqueous solutions of GRAS (generally recognized as safe) salts (PS, potassium sorbate; SC, sodium carbonate; SBC, sodium bicarbonate; SB, sodium benzoate; all at 3% (w/v)) was evaluated using 'Mollar de Elche' pomegranates artificially inoculated with the pathogens *B. cinerea* or *P. sclerotiorum*. Hot water dips at 50 ºC or higher for 2.5 min significantly reduced green mold after 7 days of incubation at 20ºC, but dips at 55 ºC or higher were phytotoxic causing heat injury on treated fruit (external rind browning). Although 3-min dips at 20 ºC in some GRAS solutions reduced the incidence and severity of both gray and green molds after 14 days of incubation at 20 ºC, these treatments were not persistent and disease reductions were not significant after 21 days. Moreover, SC and SBC dips were phytotoxic, causing external darkening and blackening of fruit crowns and areas surrounding rind wounds. In a further experiment, 3-min dips in hot water at 50 ºC or 3% PS at 20 or 50 ºC significantly reduced the incidence of gray mold with respect to control fruit (dips in water at 20ºC), but the most effective treatments (dips at 50 ºC) were phytotoxic. Overall, due to reduced efficacy and high phytotoxicity risks, hot water and the assayed GRAS salt treatments cannot be recommended for inclusion in strategies for nonpolluting integrated control of postharvest diseases of 'Mollar de Elche' pomegranates.

Keywords: *Punica granatum*, *Botrytis cinerea*, *Penicillium sclerotiorum*, postharvest decay control, heat, GRAS compounds, heated solutions

OP-25

A mobile tool for postharvest treatment and preservation of bananas using ozone

Cyndel Berger[1], Marielle Pagès-Homs[1,2], Léa Volmerange[1], Pierre Brat[3], Olivier Hubert[3], Joel Grabulos[3], Victoria Bancal[3], Alain Normand[4], Aurélien Pugeaux[4], Luc De Lapeyre de Bellaire[5], Sylvain Gerbaud[6], Lucie Nouaillac[6], Frédéric Violleau[1,7]

[1] Plateform TOAsT, University of Toulouse, INP-PURPAN, 31076 Toulouse, France. Email: cyndel.berger@purpan.fr
[2] Plant Physiology, Pathology and Genetics (PPGV), University of Toulouse, INP-PURPAN, 31076 Toulouse, France
[3] UMR- Qualisud, Dpt Persyst Qualisud, Univ Montpellier, Avignon University, CIRAD, Institut Agro, IRD, University of Reunion Island, 34398 Montpellier, France
[4] Compagnie Fruitière, 33 Bd Ferdinand de Lesseps, 13014 Marseille, France
[5] GECO, Univ Montpellier, CIRAD, 34398 Montpellier, France
[6] Absoger, 82100 Les Barthes, France
[7] Laboratory of Agro-Industrial Chemistry, LCA, University of Toulouse, INRA, 31000 Toulouse, France

Abstract
Because of its oxidizing and antimicrobial properties and its low persistence, ozone is an interesting alternative to conventional plant protection products. It can be used for preserving fruits in an ozonated atmosphere and in post-harvest treatment. The TOAsT platform team (Oxidative technologies applied to agriculture and agrifood in Toulouse), through the ATMOZFR project, has built a laboratory in a container to study this subject on different fruits such as banana. It is equipped with a cold room with four independent modules for which it is possible to regulate oxygen (O_2), carbon dioxide (CO_2) and ozone (O_3). An on-board technical room allows the generation and control of the different gases. In addition, there is a laboratory part composed of a skid for the treatment of fruits with ozonated water or ozone gas for quick applications. Finally, a module allows the water treatment by ultrafiltration combined with ozone in conditioning stations. This tool is quasi autonomous since it only needs to be connected to water and electricity. It is mobile and navigable in order to be installed as close as possible to the needs. Within the framework of the ATMOZFR project, this container was sent and installed in Ivory Coast in a banana plantation to carry out tests directly after harvest. The aim is to study the possibility of using ozone in post-harvest treatment and during the transport of bananas to improve their preservation and extend their green life. First results showed a 40% reduction in crown rot of banana artificially inoculated with *Colletotrichum musae* during storage in an ozonated atmosphere. Furthermore, ozonated water treatments appear to extend the green life of fruits.

Keywords: Ozone gas, ozonated water, container, crown-rot of banana

OP-26

Intrinsic variables with antimicrobial activity in Tamr date (*Phoenix dactylifera* L.) during storage

Bashaer M T Alkaabi, Suhaila M M Alblooshi, Durray Shahwar, Zienab F R Ahmed

Department of Integrative Agriculture, College of Agriculture and Veterinary Medicine, United Arab Emirates University, Al Ain 15551, United Arab Emirates. Email: zienab.ahmed@uaeu.ac.ae

Abstract

Understating the physicochemical and microbiological properties of fruit is necessary for postharvest handling, storage, and utilization to ensure the safety and quality of the fruit. Very limited studies have assessed the physicochemical characteristics and the microbial quality of date fruit. Therefore, the present study aimed to investigate the fruit physicochemical and microbial properties of thirteen different date cultivars grown in UAE after 6 months of storage at Tamr stage. Different date fruit varied in physical parameters; weight, size, color, and firmness. Among all cultivars, 'Razizi' cv had the lowest weight and firmness. Microbial analysis revealed that the microbial loads of the studied cultivars were significantly different. 'Nabtet saif 'and 'Sultana' cv. had significantly the highest mold/yeast and bacterial counts while 'Fard' had the lowest microbial load. Total sugar content ranged from 62 to73%, and the main sugars were glucose and fructose in most cultivars, with the exception of 'Sukkary' and 'Degla Nour' cvs. which contained also sucrose. The range of total organic acids was 200-500 mg 100 g^{-1}, with the greatest malic acid level in 'Nabtet saif' cv. and the highest acetic acid content in 'Khalas'. Investigating the fruit physicochemical and phytochemical influence on the microbial load is herein recommended.

Keywords: Date, microbial quality, organic acids, sucrose

OP-27

Effect of a hot water treatment and Timorex Gold® in the control of avocado anthracnose

José Luis Henríquez, Andrea González, Ysadora Fernández

Department of Crop Protection, Faculty of Agronomical Sciences, University of Chile, 8820000, Santiago, Chile. Email: jhenriqu@uchile.cl

Abstract

Avocado anthracnose (*Colletotrichum* spp.), is an important disease affecting worldwide production. In Chile, the disease is affecting the export industry, while management tools are not available. The aim of this study was to evaluate the effect of hot water alone or mixed with Timorex Gold® (TG), (tea tree oil a.i.) on avocado anthracnose. Sensitivity to hot water of mycelia of *C. gloeosporioides*, *C. cigarro,* and *C. pyricola*, was evaluated at temperatures of 25, 50 and 60 °C. Agar plugs with mycelium of the pathogens were treated for 1 or 3 minutes, then cooled and plated on potato dextrose agar and incubated at 20 °C. Hass avocados were harvested from an orchard with high incidence of anthracnose and dipped in water at 25 °C (control), water at 50 or 60 °C for 3 and 1 minute, respectively, water at 50 or 60 °C for 3 and 1 minute plus TG at 2%, TG at 2%, and prochloraz as a commercial standard. Fruit was stored at 7 °C for one week and then left at room temperature. *Colletotrichum cigarro* was the most sensitive species to hot water with a complete inhibition after exposition at 50 °C for 3 minutes and at 60 °C for 1 and 3 minutes. *C. pyricola* was completely affected only at 60 °C for 3 minutes. *C. gloeosporioides* grew after being treated with hot water at both temperatures and exposition times. Immersion of avocados for 1 minute at 60 °C reduce the incidence and severity of anthracnose similar to the standard fungicide. The addition of TG did not increase the effectivity of hot water. Hot water at 50 °C for 3 minutes and TG alone did not affect the level of disease. Hot water treatment at 60 °C for 1 minute did not affect the color of the flesh nor fruit firmness, but the skin of the fruits turned black.

Keywords: *Persea americana*, postharvest rot, physical control, tea tree oil, *Colletotrichum* spp.

OP-28

Transcriptomic, metabolic and pathogenicity profiling of *Botrytis cinerea* under cold stress

Carmit Ziv, Lavanya Gunamalai, Ginat Raphael

Department of Postharvest Science, Agricultural Research Organization ARO, Volcani Institute, 7505001 Rishon LeZion, Israel. Email: carmit.ziv@agri.gov.il

Abstract

Postharvest fungal pathogens are a significant threat causing loss of fresh fruits and vegetables that is estimated at approximately 30 percent of total crop yield worldwide. Low temperature (LT) slows cellular respiration and metabolic activities, which delay fruit senescence/maturation and slow down the growth of pathogenic microorganisms. Thus, storage at LT is an effective mean for prolonging postharvest crop production with limited negative effects on human health and the environment. Some phytopathogenic fungi, such as *Botrytis cinerea* - the necrotrophic grey mold fungal pathogen, are highly tolerant of LT conditions and can develop during cold storage causing rotting of fruit. Together with a wide range of molecular resources, the availability of a completely sequenced genome makes it a convenient model ascomycete for researching various aspects of fungal growth and virulence factors. To uncover the molecular basis of *B. cinerea* cold tolerance, we characterized its morphology and physiology at different temperatures and identified a marked variability in morphological features including hyphal pattern during vegetative growth, conidiation and formation of sclerotia. While growth rate and conidiation were significantly reduced at LT, conidial germination was not impaired and was only mildly delayed. Interestingly, although infection at LT was significantly slower than at ambient temperatures, *Botrytis* virulence was not impaired and conidiation was not suppressed by the LT during pathogenic interactions. Several cold stress pathways, including ROS metabolism, membrane lipid remodeling and osmo-regulators biosynthesis, have been analyzed to evaluate their involvement in the response to cold stress. Our interpretation of the molecular basis of *B. cinerea* infectivity under cold conditions is supported by correlating morphology to transcriptomic and metabolic changes during growth at LT. This understanding may pave the way for the development of environment-friendly control treatments against cold-tolerant fungal pathogens, to reduce produce loss in cold storage.

Keywords: Cold-storage, lipids, Reactive Oxygen Species, trehalose

OP-29

Novel Chitosan/poly-vinyl-alcohol/Thyme oil@Na-montmorillonite and ZnO@Na-montmorillonite edible active coatings for extended self-life of tofu sausages

Aris Giannakas[1], Constantinos Salmas[2], Eleni Kollia[3], Anna Kopsacheili[3], Christina Birlia[3], Charalampos Proestos[3]

[1] Department of Food Science and Technology, University of Patras, Agrinio 30100, Greece
[2] Department of Materials Sci. & Engineering, University of Ioannina, Ioannina 45110, Greece
[3] Department of Chemistry, Laboratory of Food Chemistry, National and Kapodistrian University of Athens, Athens, Greece. Email: harpro@chem.uoa.gr

Abstract
In this work, a thyme oil adsorbed in commercial organo-modified Na-montmorillonite (TO@OrgMt) nanostructure and a ZnO growth on Na-montmorillonite (ZnO@OrgMt) nanostructure were dispersed in chitosan(CS)/poly-vinyl-alcohol(PVOH) matrix to give novel CS/PVOH/TO@OrgMt and CS/PVOH/ZnO@NaMt edible active coatings. Both CS/PVOH/TO@OrgMt and CS/PVOH/ZnO@NaMt were applied as active coatings to extend tofu sausages self-life. Pure CS and CS/PVOH coatings were also used as blank samples. Sausages after coating were stored at 7 °C and microbiological analysis was performed for the total count of mesophilic, psychrotrophic, and lactic acid bacteria as well for 30 days. Coated samples were compared to uncoated sausages (UC) and vacuum-packed sausages (VP). There is no specific European legislation outlining the maximum allowable microbial counts in tofu. However according to the «Soyfoods Association of America's Tofu», tofu products are considered marginally acceptable for consumption when the microbial count is lower than 10^6- $10^{6.7}$ CFU g^{-1}. Most of the tofu sausage samples used on day 0 were above the acceptable limit 10^5- 10^6 CFU g^{-1} but within the marginally acceptable limit. After coating, a decrease in the mesophilic bacteria population was observed in all cases (<10^5 CFU g^{-1}). Moreover, psychrotrophic and lactic acid bacteria growth was also delayed for all the coating treatments in comparison to UC and UC/ VP sausages. Based on microbiological quality, the shelf life of the tofu sausages was extended, since 12 days before the commercial expiry date, the microbial count was still low (<10^5 CFU g^{-1}). Finally, no negative impact on the odor of the treated samples was noticed. However, changes in the color and the tenderness (dehydration) was observed.

Keywords: Tofu sausages, chitosan, antimicrobial, edible coatings

OP-30

Novel Chitosan/polyvinyl alcohol/thyme oil modified nanostructures edible coatings affected cherry tomatoes storage

Panayiota Xylia[1], Efraimia Hajisolomou[1], Antonios Chrysargyris[1], Katerina Kyriakou[2], Constantinos Salmas[3], Aris Giannakas[2], Charalampos Proestos[4], Nikolaos Tzortzakis[1]

[1] Department of Agricultural Sciences, Biotechnology and Food Science, Cyprus University of Technology, 3036 Limassol, Cyprus. Email: efraimiahadjisolomou@gmail.com
[2] Department of Food Science and Technology, School of Agricultural Sciences, University of Patras, Agrinio, 30100, Greece
[3] Department of Material Sci. & Engineering, University of Ioannina, Ioannina 45110, Greece
[4] Laboratory of Food Chemistry, Department of Chemistry, National and Kapodistrian University of Athens Zografou, 157 71 Athens, Greece

Abstract

Tomato is one of the most widely consumed fresh fruit in the world but extremely perishable. Edible coatings serve as the best possible alternative to reduce the post-harvest losses by delaying the ripening of tomato and increasing the shelf life without affecting the quality. The following biodegradble and or biobased materials were used for edible coating preparation: Chitosan (CS; 2%), poly-vinyl-alcohol (PVOH), Halloysite (HNT; 15%), natural edible zeolite (NZ; 15%), activated carbon (AC; 15%), and thyme oil (TO). Greenhouse grown cherry tomatoes were coated by dipping method as follow: (i) control (dH_2O), (ii) CS, (iii) CS/PVOH, (iv) CS/PVOH/HNT-TO, (v) CS/PVOH/NZ-TO and (vi) CS/PVOH/AC-TO. Fruit weight loss, respiration rates and marketability were evaluated every four days, while fruit sampling and quality-related attributes measurements took place at the 12th day of storage at 11 ^{o}C and 90% relative humidity (RH). The applications of CS/PVOH/HNT-TO, CS/PVOH/NZ-TO and CS/PVOH/AC-TO had lower titratable acidity than the control. Fruit respiration was delayed in CS treated tomatoes in comparison to the control and other CS-based coatings. Fruit aroma, appearance and marketability revealed greater scores at the control, and followed by CS, CS/PVOH, and CS/PVOH/HNT-TO applications. No differences were found in fruit weight loss, firmness, colour (lightness, redness etc), total soluble solids, fruit decay but also on the lesion growth of *Botrytis cinerea* inoculated tomatoes. However, *Botrytis* spore germination and spore production were inhibited with the presence of PVOH and/or modified TO applications (treatments iii, iv, v, and vi). Edible coating is an effective sanitation mean to maintain fresh produce with antimicrobial properties for postharvest storage of commodities.

Keywords: Edible coating, chitosan-based coating, essential oils, respiration rates, cherry tomatoes

OP-31

How light wavelengths affect *Monilinia* spp.: from *in vitro* development to virulence on nectarines

Lucía Verde Yáñez, Núria Vall-llaura, Josep Usall, Neus Teixidó, Rosario Torres

Institute of AgriFood Research and Technology (IRTA) Fruitcentre, Postharvest Program, Lleida, 25003 Catalonia, Spain. Email: lucia.verde@irta.cat

Abstract

Brown rot disease caused by the necrotrophic fungus *Monilinia* spp. is influenced by many abiotic factors, such as temperature, humidity, and light. However, there are scarce studies aiming to analyse the effect of light wavelength on the development and virulence of *Monilinia* spp. This study assesses the effect of light wavelengths on the *in vitro* development, the regulation of putative virulence genes and the virulence of the main species of *Monilinia* (*M. laxa*, *M. fructicola* and *M. fructigena*). After exposing the species of *Monilinia* to different light wavelengths (white, black, blue, red, far-red) for 7 days, the results revealed differences in the phenotype among light conditions and among species. Thus, the different light conditions induced changes on the colony pigmentation, on the colony growth and specially on the ability to conidiate. In this sense, *M. laxa* produced more conidia under white and blue light wavelengths, while in the case of *M. fructicola*, it occurred subjected red and darkness conditions. The growth rate increased under far-red and black light wavelengths for both *M. laxa* and *M. fructicola*, while no statistical differences were observed for *M. fructigena*. The analysis of 13 putative virulence genes revealed a different expression pattern among *Monilinia* spp. and light wavelengths. The virulence of the species on nectarines was reduced in *M. laxa* and *M. cola* under black light but not in *M. fructigena*. Overall, results demonstrated the importance of light wavelengths are a key abiotic factor for the biology of *Monilinia* spp., specially modulating its capacity to form conidia, and thus, influencing its spreading and the onset of the disease on nectarines during postharvest.

This work was supported by project AGL2017-84389-C2-1-R from the Spanish Government by PhD grant PRE2018-085428 (L.V.-Y.) and the CERCA Programme/Generalitat de Catalunya.

Keywords: Abiotic factor, brown rot, conidiation, *Prunus persica*, stone fruit, postharvest

OP-32

Alternative means for controlling pomegranate postharvest decay

Annamaria Mincuzzi[1], Simona Marianna Sanzani[1], Marika Caputo[1], Pasquale D'Ambrosio[1], Lluìs Palou[2], Marco Ragni[1], Antonio Ippolito[1]

[1] Department of Soil, Plant, and Food Sciences, University of Bari Aldo Moro, Via Amendola 165/A, 70126 Bari, Italy. Email: annamaria.mincuzzi@uniba.it
[2] Centre de Tecnologia Postcollita (CTP), Valencian Institute of Agrarian Research (IVIA), Ctra. CV-315, Km 10.7, 46113 Montcada, Valencia, Spain.

Abstract

Pomegranate (*Punica granatum* L.) cultivation in southern Italy is gaining increasing interest due to favorable environmental conditions and the beneficial effects on human health. Both, in the field and postharvest product losses, especially in organic fruit production, represent the chief concern for this high-priced chain. Main postharvest pomegranate diseases are caused by latent pathogens that infect pomegranates during blooming stage (*Coniella granati*, *Alternaria* spp., *Botrytis* spp.), and secondarily by wound pathogens (*Penicillium* spp. and *Aspergillus* spp.) affecting fruit during processing from harvest until storage. The aim of this research was to test alternative control means and strategies suitable in organic pomegranate orchards, able to control postharvest decays reducing yield losses, and easily endorsed by the farmers. To control diseases caused by the above-mentioned fungal pathogens, the effectiveness of three alternative control means, already marketed, was evaluated on pomegranates cv Wonderful. Particularly, the effectiveness of a red seaweeds extract, a plant protein hydrolysate, and a chitosan solution were compared with fludioxonil+cyprodinil (chemical control) and water (not treated control). Three different methods of administration were tested: in the field spraying, postharvest dipping, and the combined treatments. After 4-months of cold-storage, incidence of stamina infections, and external and inner decays were assessed. Overall, results disclosed preharvest application of red algae extract as the most effective treatment in reducing both incidence and severity of postharvest decays. Inner decay incidence was significantly reduced by plant protein hydrolysate. Further in the field trials are in progress to confirm the results obtained.

This work was conducted within the framework of the PRIMA StopMedWaste project, which is funded by PRIMA, a programme supported by the European Union.

Keywords: Pomegranate, postharvest diseases, *Coniella granati*, *Alternaria* spp., *Botrytis* spp., control, seaweeds extract, plant protein hydrolysate, chitosan

OP-33

Essential oils and natural plant extracts as antifungal ingredients of pectin-based edible composite coatings to control green mold and maintain postharvest quality of `Valencia´ oranges

María V. Alvarez[1], Lluís Palou[2], Verónica Taberner[2], Asunción Fernández-Catalán[2], Victoria Martínez-Blay[2], Maricruz Argente-Sanchis[2], María B. Pérez-Gago[2]

[1] Food Engineering Group, Faculty of Engineering, National University of Mar del Plata, CONICET, 7600, Mar de Plata, Argentina
[2] Postharvest Technology Center, Valencian Institute of Agricultural Research (IVIA), 46113 Montcada, Spain. Email: perez_mbe@gva.es

Abstract

Pectin-beeswax edible coatings containing essential oils (EOs) and plant extracts as antifungal ingredients have been developed to reduce postharvest losses in 'Valencia' oranges. After *in vitro* evaluation of the antifungal activity of the ingredients against *Penicillium digitatum*, selected agents and concentrations (0.2-2%, w/w) were incorporated into the coating. The curative activity of antifungal edible coatings (AECs) to control green mold was tested on artificially inoculated oranges incubated 8 days at 20°C. The effects of selected AECs on green mold and fruit physicochemical and sensory quality were tested on oranges stored for up to 8 weeks at 5°C plus 1 week at 20°C. Commercial compounds evaluated *in vitro* were cinnamon (CN), lemongrass (LG), *Satureja montana* (SM), myrrh (MY), eugenol (EU), geraniol (GE), green tea extract (GT), propolis (PRO), and vanillin (VA). Mycelial growth inhibition of *P. digitatum* after 7-14 days of incubation at 25°C was evaluated in PDA media exposed to EOs volatiles or by direct contact with the extracts using the agar dilution method. CN, SM, EU and GE (at a dose of 20 µL) inhibited the fungus radial growth by 90-100%; whereas, VA, PRO and MY were effective at 0.125-0.5%. After 8 days of incubation at 20°C, AECs containing 0.2% GE, 0.8% EU or 1.5% MI reduced green mold incidence (infected fruit, %) on oranges by more than 40%, while the highest reduction in disease severity (lesion diameter, mm) was observed with 0.8% CN. After 4 weeks of cold storage, 0.2% GE and 0.8% EU-based coatings reduced disease incidence by more than 50%, and 0.8% EU-coating was the most effective to reduce severity. In addition, the 0.8% EU-based coating was the most effective to reduce weight loss and provided the highest gloss on coated oranges at the end of the storage, showing its potential to reduce citrus postharvest losses.

Keywords: Citrus, *Penicillium digitatum*, disease control, natural antifungal agents, postharvest quality

OP-34

Efficacy of biofumigation with essential oils in the control of postharvest rots on nectarines

Giada Schiavon, Marco Garello, Davide Spadaro

Department of Agricultural, Forest and Food Sciences and Centre of Competence AGROINNOVA, University of Torino, 10095 Grugliasco, Italy. Email: marco.garello@unito.it

Abstract

The most common postharvest pathogens on nectarines are *Monilinia fructicola* and *M. laxa*, followed by minor pathogens. The efficacy of five essential oils (EOs) was evaluated against postharvest rots on nectarines. Biofumigation of EOs of red thyme, fennel, basil, oregano, and lemon at a concentration of 2% were evaluated to control brown rot. Disease incidence was evaluated after 14 days of storage at 1°C and after further 7 days shelf-life at 20°C. At the end of storage, nectarines treated with fennel EO showed a significant reduction in rots, whereas the other EOs were not compared to the inoculated control. Isolations from fruit rots showed a prevalence of *Monilinia* spp., followed by *Botrytis cinerea* at the end of storage, and of *Monilinia* spp., with minor occurrence of *Penicillium* spp., *Botrytis* spp., and *Rhizopus* spp. at the end of shelf-life. In the second trial, biofumigation was realized with EOs of fennel, basil, and lemon at the same concentration. Disease incidence was evaluated after a longer storage (28 days) at 1°C and after further 5 days shelf-life at 20°C. At the end of storage, nectarines treated with EOs showed a significant reduction in rots, which were caused by *Monilinia* spp. At the end of shelf-life, the agents of rots were *Monilinia* spp., *Penicillium* spp., *Botrytis* spp., *Alternaria* spp., and *Rhizopus* spp.. In the second trial, fruit quality and microbiome composition were analysed at harvest, after 28 days of storage, and after 5 days of shelf-life. The firmness in the treated fruits with EOs was higher compared to the untreated ones. Treatments with biofumigation with EOs are promising tools for the control of postharvest rots.

This work was conducted within the framework of the PRIMA StopMedWaste project, which is funded by PRIMA, a programme supported by the European Union.

Keywords: Nectarines, *Monilinia* spp., essential oils, biofumigation, postharvest disease, brown rot

OP-35

Effects of ozone treatment on postharvest decay of peach fruits in cold storage

Annamaria L. D'Ortenzio, Sarah Mojela Makau, Valeria Mancini, Simone Piancatelli, Marwa Moumni, Lucia Landi, Gianfranco Romanazzi

Department of Agricultural Food and Environmental Sciences, Marche Polytechnic University, Via Brecce Bianche, 60131 Ancona, Italy. Email: m.moumni@staff.univpm.it

Abstract

The maintenance of high-quality standards for prolonging the shelf life of fruit is a priority for horticultural products, and fungal infection is one of the main problems of peach fruit in pre- and postharvest. This study investigated the effects of preharvest treatment using two types of sprayers (traditional and innovative with flow control), and postharvest treatment using ozone in storage temperature on the quality of peach fruit. The experiment was carried out in Marche Region, Central-Eastern Italy, on peach cultivars Summer Royal and Extreme 486, sprayed with fungicides (tebuconazole in 2020 and boscalid+pyraclostrobin in 2021) in the field and after 7 days harvested separately for each type of sprayer. Immediately after harvest, peach fruits were stored at 4 °C with or without ozone treatment (100-250 ppb and 50-100 ppb during the day and night, respectively) for 10 and 20 days. Fruits were removed from cold storage, transferred at 20 °C and then the decay was measured daily during 8 days shelf life. Concentration of 250 ppb used during the night on cv Extreme 486 induced phytotoxic effects on peach fruits. The main agent of rot identified on peach fruit during shelf life were *Monilinia* spp., *Rhizopus* spp., and *Fusarium* spp. Treatment with ozone during cold storage reduced decay incidence in a range among 10 to 70%. In all trials, traditional sprayer protected the fruits better than innovative one. The application of ozone can contribute to the management of postharvest diseases of peaches, and concentrations to be applied need to be tested on specific cultivars to monitor eventual phytotoxic effects.

This work was conducted within the framework of the PSR ZeroSprechi and of PRIMA StopMedWaste project, which is funded by PRIMA, a programme supported by the European Union.

Keywords: Cold storage, *Monilinia* spp., peach, ozone, sprayers, shelf life

OP-36

Antifungal activity of thirty essential oils to control pathogenic fungi of postharvest decay under cold storage

Marwa Moumni[1], Ibtissem Hannachi[2], Hajer Ben Amara[2], Gianfranco Romanazzi[1], Mohamed Bechir Allagui[2]

[1] Department of Agricultural, Food and Environmental Sciences, Marche Polytechnic University, 60131 Ancona, Italy
[2] Laboratory of plant Protection, National Institute for Agronomic Research of Tunisia, University of Carthage, rue Hedi Karray, 2080 Ariana, Tunisia. Email: allagui.bechir@gmail.com

Abstract
Essential oils (EOs) extracted from aromatic or medicinal plants are biodegradable, safe and considered as an environmentally solution to reduce fungal species attacking different crops. Isolation and morphological identification of fungi causing postharvest disease in plum fruits (*Prunus salicina*) cv. "Friar" were *Alternaria alternata*, *Botrytis cinerea* and *Penicillium italicum* as major postharvest fungal species of plum fruits. In this study, the antifungal activity of 30 EOs was tested against these fungi on PDA at 500 µg mL^{-1} and 10 °C. The EOs from *Caryophyllus aromaticus, Cinnamomum verum, Cymbopopon citratus* and *Gaultheria fragrantissima* showed high antifungal activity, in PDA medium, since they completely inhibited mycelial growth of the species *B. cinerea*, *P. italicum* and *A. alternata*. The bioassay on plum fruits inoculated with *A. alternata* and treated with *C. aromaticu* oil at 500 µg mL^{-1} exhibited a 40% decay reduction compared to the control, after three months of storage at 10 °C. Our study showed that the *C. aromaticus* oil has the potential to control Alternaria rot without causing injury or harmful effects on stored plum fruits, and it can be a strategy for maintaining quality and extending shelf life.
This work was conducted within the framework of the PRIMA StopMedWaste project, which is funded by PRIMA, a programme supported by the European Union.

Keywords: Blue mold, gray mold, essential oils, shelf life, stone fruits

OP-37

PRIMA StopMedWaste contribution to postharvest industry

Clara Montesinos

Decco Ibérica Post-harvest SAU, Villa de Madrid 54, 46988 Paterna, Spain. Email: clara.montesinos@upl-ltd.com

Abstract

During decades, all researchers working on alternatives to synthetic fungicides in postharvest were claiming the need to stop using synthetic fungicides that would damage human health and environment. The time has arrived when European Authorities and supermarket chains are implementing a strong policy of reducing the use of these conventional treatments to an extreme that puts the fruits and vegetables production in risk of dangerously increasing their waste rates. With increasing restrictions to use synthetic pesticides and fungicides, lack of effective tools to reduce waste is leaving producers without profitability. Alternative effective treatments in pre and postharvest are more necessary than ever. StopMedWaste is aiming to provide market with natural or non-contaminant treatments that can be accepted by the new strategies of market and still protect fruits and vegetables from waste during postharvest and shelf life. Industry is eager to commercialize this type of products and collaboration between research institute, universities and industry is crucial if we want to succeed in the objective of maintain sustainable resources of fruits and vegetables.

Keywords: Sustainability, postharvest, PRIMA, StopMedWaste

OP-38

OPTIROOT - Optimization of produce quality and storage conditions to reduce loss during long-term storage of root vegetables in Norway ' mapping of stores

Mette Goul Thomsen[1], Erlend Indergaard[2], Belachew Asalf[3], Pia Heltoft[1]

[1] Division of Food Production and Society Horticulture. NIBIO, Norwegian Institute of Bioeconomy, Nylinna 226, 2849 Kapp, Norway. Email: mette.thomsen@nibio.no
[2] Division for Fishery and New Biomarine Industry, Sintef Ocean AS., 7034 Trondheim, Norway
[3] Division of Biotechnology and Plant Health, Norwegian Institute of Bioeconomy, Høgskoleveien 7, 1433 Ås, Norway

Abstract
In OPTIROOT six vegetable producers, 28 vegetable stores, cooling technology companies, sensor and biopesticide developer, packaging manufacturers, The Norwegian Agricultural Service, Growers association and five research institutes cooperated to reduce storage loss of carrots, swede, and celeriac. Temperature and humidity were measured in 28 vegetable stores and compared to quality of stored vegetable through two storage seasons. The vegetables swede, carrot and celeriac were grown at one site within each of the four regions in Norway ROG, MID, INN and OSL, respectively. After harvesting, the vegetables were weighed and visually assessed for any injuries or diseases and stored in different stores within the same region as grown. Four bags (100 carrots/25 cabbage or celeriac root per bag) distributed in four storage crates in each store. Each bag also containing a logger measuring temperature and humidity. Correlating data on quality with temperature data shows for carrot a tendency to increase in the proportion of fresh roots and reduction in incidence of tip-rot by an increased average temperature during the first two weeks of storage. An increase in accumulated temperature during the storage periods showed a tendency to increase the emergence of tip-rot and reduce the proportion of fresh roots. For celeriac, the effect of temperature varied between years, possibly due to a large difference in quality in the two test years, and it was difficult to draw any conclusion. In swede, the results suggest that a decrease in temperature in the first two weeks of storage increased the risk of the symptom shown as black rings in the phloem. Data showed that region as well as quality of store and regulation of storage atmosphere affected produce quality through the storage period.

Keywords: Storage temperature, mapping, carrot, swede, celeriac, tip-rot

OP-39

Essential oils and other natural products for the preservation of shredded carrots

Panayiota Xylia, Antonios Chrysargyris, George Botsaris, Nikolaos Tzortzakis

Department of Agricultural Sciences, Biotechnology and Food Science, Cyprus University of Technology, 3603 Limassol, Cyprus. Email: pa.xylia@edu.cut.ac.cy

Abstract

A great interest on the investigation of natural products (i.e., essential oils-EOs, organic acids, and edible coatings) as postharvest sanitizers has been noticed in an attempt to minimize the use of chemical synthetic compounds (i.e., chlorine) in the food industry. This work aims to present the outcomes of natural products application (essential oils, hydrosols and ascorbic acid) on shredded carrots quality with two separate experiments. The application of mint EO, mint hydrosol (Hyd) and pomegranate juice on shredded carrots inoculated with human foodborne pathogens (*Escherichia coli*, *Listeria monocytogenes*) decreased both bacterial populations. Mint EO was found to decrease polyphenols and antioxidants, whereas an increase was observed with pomegranate juice and mint Hyd. In another experiment, marjoram EO (1:1500 v/v), marjoram Hyd (1:15 v/v), ascorbic acid (AA, 1% w/v) and their combinations when applied on shredded carrots revealed that EO and AA were able to preserve the product (acceptable aroma and bright orange color), whilst marjoram Hyd resulted in darker (brown) color. Moreover, the combinations of AA with marjoram EO and hydrosol (AA+EO, AA+Hyd) were found to increase shredded carrot's total carotenoid content. All applied single or combined treatments decreased the microbial load, while AA increased total phenols and antioxidants of shredded carrots. Single and/or combined natural products can be considered as promising alternative sanitizing agents used in the food industry, as long as the optimum scenarios (concentration, time and method of application) are investigated for each produce.

Keywords: Ascorbic acid, chitosan, essential oils, hydrosol, minimally processed vegetables, postharvest quality

POSTER PRESENTATIONS

PP-1

Postharvest fungal pathogens of apple in Nigde province, Turkey

Keziban Sinem Tulukoglu Kunt[1], Mustafa Ozden[1], Sibel Dervis[2]

[1] Department of Plant Production and Technologies, Nigde Omer Halisdemir University, 51240, Nigde, Turkey. Email: ksinemtulukoglu@gmail.com
[2] Vocational Higher School of Kızıltepe, Mardin Artuklu University, 47400, Mardin, Turkey

Abstract
Apples are an economically important horticultural product worldwide. They can be stored under low temperature for long periods of time (up to 10 months). However, fungal decay is a major problem in long-term storage and causes serious postharvest fruit loses around the world, including Turkey. This decay is caused by several fungi with different infection mechanisms favored by different conditions. Therefore, it is crucial to know which fungal pathogens are the primary cause of any decay in order to develop innovative control strategies. For this reason, the aim of this study was to sample decaying apples from cold storage facilities in Niğde Province, Turkey (an important apple-producing province) to isolate and identify the pathogens. A total of 395 visually infected apples were sampled from 18 cold storage facilities in the 2020/21 production season. Culture morphology of the isolates was examined, isolates were morphologically identified at the genus level. The results showed that the identified dominant genera considered of major contributors to fruit spoilage belonged to genus *Penicillium* (76.5%), followed by *Alternaria* (19.0%). Other fungal pathogens, including species of *Botrytis*, *Cadophora*, *Cladosporium* and *Fusarium* had low abundance. Pathogenicity testing and molecular characterization of the isolates is in progress.

Keywords: Cold storage, fungal diseases, decay, *Malus domestica*

PP-2

Etiology of fungal decay during the controlled atmosphere storage of 'Fuji' and 'Gala' under commercial conditions

Rachael Maree Wood[1], Luiz Carlos Argenta[2], Marcelo José Vieira[3], Claudio Ogoshi[2], Daniel Alexandre Neuwald[1]

[1] Competence Centre for Fruit Growing, at Lake Constance, 88213, Ravensburg, Germany. Email: neuwald@kob-bavendorf.de
[2] Experimental Station of Caçador, Agricultural Research and Rural Extension, Institute of Santa Catarina EPAGRI, 89501-032 Caçador-SC, Brazil
[3] Fischer SA Agroindústria, Rodovia SC 355, km 24, 89580-000 Fraiburgo-SC, Brazil

Abstract
Storage rot (or decay) is the primary cause of post-harvest losses in integrated apple production worldwide. At harvest, fruit can appear free from infection but develop symptoms later during long-term storage, making treatment and prediction of fungal growth during storage challenging. Therefore, this study was conducted to observe the etiology of several fungal pathogen species during long term storage under a controlled atmosphere (CA). Commercial data of disease incidences over 17-years were collated and analyzed. 'Fuji' and 'Gala' fruit were grown between 2002 and 2018 in commercial orchards in southern Brazil. The orchards represented a 'warm' growing site with a low altitude and a 'cold' growing site with a higher altitude. Decay incidences were performed every month for eight months. Results showed that total disease incidence increased as the storage duration increased. Storage decay was primarily caused by *Neofabraea* spp. (Bull's eye), followed by *Penicillium* spp. (blue mold) and *Botrytis* spp. (gray mold). 'Fuji' apples had higher incidences of decay during CA-storage than 'Gala' due to higher incidences of *Alternaria* spp. and *Fusarium* spp. (moldy core rot). For both cultivars, fruit from the warm site had higher incidences of Bull's eye rot than the cold site. For 'Fuji', fruit from the warm site had higher incidences of moldy core rot than the cold site. There was an increasing trend in disease incidence for both cultivars and growing sites over the 17-year study. However, the yearly increase in disease incidence was more prominent for the 'warm' site. For both locations, high incidences of storage rot occurred when high average temperatures occurred concurrently with high annual rainfall.

Keywords: Controlled atmosphere storage, *Malus* × *domestica* Borkh., *Neofabraea* spp., postharvest disease, storage rot

PP-3

Assessment of sensitivity to boscalid, fluopyram and tebuconazole in *Monilinia fructicola* isolates obtained from peach orchards in Greece

Stefanos Testempasis, Vasiliki Tsintila, George Karaoglanidis

Plant Pathology Laboratory, Faculty of Agriculture, Forestry and Natural Environment, Aristotle University of Thessaloniki, 54124, Thessaloniki, Greece. Email: testempasis@gmail.com

Abstract

Brown rot is one of the most important diseases of stone fruit worldwide. In most European countries, the main agents of Brown rot were considered to be *Monilinia laxa* and *M. fructigena*. However, during the last decade *M. fructicola* has been found in high frequencies in most countries around the Mediterranean basin, including Greece. Taking into account that *M. fructicola* is considered to be of higher risk for fungicide resistance development compared to *M. laxa* or *M. fructigena*, this study was initiated aiming to determine the fungicide sensitivity profile of isolates originating from peach orchards in Greece. In total, 230 *M. fructicola* isolates were collected and assessed for their sensitivity to the SDHI fungicides boscalid and fluopyram and the DMI fungicide tebuconazole. Sensitivity assays were based on the inhibition of germ tube or the mycelial growth for SDHIs and DMIs, respectively. The assays revealed that 53.9% of the isolates (n=124) were sensitive to all the three fungicides tested, while 46.1% (n=106) were characterized as resistant. In detail, 7.8% (n=18) and 8.7% (n=20) of the SDHI-resistant subpopulation had a resistance factor (RF) higher than 2 to fluopyram and boscalid, respectively. In addition, a high percentage (29.6%) of the isolates (n=68) were resistant to tebuconazole with a RF values ranging from 2 to 13. To the best of our knowledge, this is the first report of resistant strains of *M. fructicola* to SDHIs and DMIs in Greece. Ongoing studies will elucidate the molecular mechanisms of resistance in these isolates.

This research has been co-financed by the European Union and Greek national funds through the Operational Program Competitiveness, Entrepreneurship and Innovation, under the call RESEARCH–CREATE–INNOVATE (project code: T1EDK- 04591).

Keywords: Brown rot, fungicide, resistance, SDHIs

PP-4

Detection and identification of fungal storage pathogens on apples before and after harvest in Austria

Ulrike Persen[1], Richard A. Gottsberger[2], Thomas Leichtfried[2], Juliane Reiterer[2]

[1] Department for Plant Health in Fruit Crops, Viticulture & Special Crops, Austrian Agency for Health and Food Safety, 1226 Vienna, Austria. Email: ulrike.persen@ages.at
[2] Department for Molecular Diagnostics of Plant Diseases, Austrian Agency for Health and Food Safety, 1226 Vienna, Austria

Abstract
Fungal storage pathogens on pome fruits cause economic losses worldwide. For most storage diseases, fruits are already infected in the field but remain symptomless before harvest. To be able to apply sufficient preventive control measures, it is necessary to know the relevant pathogens in a region. Consequently, a survey in Austrian pome fruit storages was conducted from 2018 - 2020. The risk for infections depends on suitable weather conditions, susceptibility of different cultivars, orchard sanitation or other plant protection measures and timing of harvest. Therefore, the incidence of storage rots varies between years. The main detected rot causing fungi within the first three months after harvest were: *Monilinia fructigena*, *Fusarium* sp., *Botrytis cinerea* and *Penicillium* sp.. Additionally, *Neofabraea* spp., (predominantly *N. vagabunda*) and *Alternaria* sp. developed during longer cold storage periods. As a result, the focus of further investigations was on *Neofabraea* spp., the causal agent of Bull's eye rot. This disease occurs regularly in Austrian cold storages and is initiated from a preharvest latent infection of the fruit. Within a research project (coordinated under ERA-NET EUPHRESCO frame network) the incidence of these pathogens before harvest was recorded. The presence of the pathogens on the surface and in the peel of apples of different cultivars was investigated using molecular tools, supplemented by morphological studies. Samples were collected both from organic and conventional orchards. *N. vagabunda* has been detected in the washing water of apples in all samples taken between June and September. The fungal diversity on the fruit surface at harvest time has also been assessed. This could serve as a starting point for the prediction of postharvest rots during storage.

Keywords: Postharvest disease, isolation, identification, qPCR, diversity, latent infection, *Malus*

PP-5

First genome sequences of *Neofabraea* species responsible for anthracnose, perennial canker and post-harvest bull's eye rot of apple

Greice Amaral Carneiro[1], Sanja Baric[1], Selena Tomada[1], Andreas Bühlmann[2]

[1]*Faculty of Science and Technology, Free University of Bozen-Bolzano, 39100 Bozen-Bolzano, Italy*
[2]*Research Division Food Microbial Systems, Agroscope, 8820 Wädenswil, Switzerland. Email: andreas.buehlmann@agroscope.admin.ch*

Abstract

Neofabraea species are among the most important pathogens of apple (*Malus domestica*) worldwide, but also of several other host plants such as pear and olive. *N. alba* (syn: *N. vagabunda*) is the dominant species associated with the post-harvest bull's eye rot of apple in continental Europe, while *N. malicorticis* and *N. perennans* are also traditionally related to anthracnose and perennial canker of apple, respectively. *N. kienholzii* is the most recently described species of the genus, documented in North East America and Europe. To date, many aspects of *Neofabraea* spp. biology have not been investigated and their identification is mainly based on evaluation of morphological features such as symptoms and manifestations of signs on diseased apples, fungal mycelium appearance on nutrient media, types of fruiting bodies and spores. In addition, these species are distinguished by sequencing of DNA segments such as *β*-tubulin and translation elongation factor 1-*α* genes. However, there is still no consensus among mycologists on the molecular markers most reliable for the distinction of species within this genus. The main objective of this work was to provide, for the first time, the whole genome sequences and genome annotations of one representative isolate of each of the four principal pathogenic species of *Neofabraea*. To explore the most suited sequencing strategy for these fungal species, different fungal growth conditions, DNA extraction protocols, as well as next-generation sequencing (NGS) technologies such as Illumina MiSeq, Oxford Nanopore and PacBio SMRT Sequencing were evaluated. The availability of complete genomic data of species belonging to the genus *Neofabraea* will represent a new resource useful for comparative genome analysis, which may also contribute to a better understanding of the evolution and taxonomy of this genus. Furthermore, this knowledge will be utilized for functional genomics studies or the exploration of genetic elements governing vital biological and pathological processes.

Keywords: DNA extraction protocol, next-generation sequencing technologies, genome annotation, fungal growth conditions, diagnosis

PP-6

Patulin-deficient knockout mutants of *Penicillium expansum* as potential biocontrol agents

Belén Llobregat, Luis González-Candelas, Ana-Rosa Ballester

Food Biotechnology Department, Institute of Agrochemistry and Food Technology (IATA-CSIC), Calle Catedrático Agustín Escardino 7, 46980 Paterna (Valencia) Spain. Email: belen.llobregat@iata.csic.es

Abstract

Penicillium expansum causes an economically important postharvest disease known as blue mold rot and is one of the most studied and well-known fungi of the genus *Penicillium*. In addition to its significant pathogenicity on harvested fruits, it produces a wide range of secondary metabolites (SM). Among them, patulin is the most well-researched and documented mycotoxin. This polyketide-derived mycotoxin causes a high number of toxic effects, including cytotoxicity, genotoxicity and immunotoxicity. This fact has triggered a global concern in the society due to the negative impact on food and feed produce, health, and economy. The gene cluster responsible for patulin biosynthesis in *P. expansum* comprises 15 genes (*patA* - *patO*); being *patK* the gene encoding 6-methylsalicylic acid synthase, the first enzyme of the patulin biosynthesis pathway. Besides that, it is known that both pathway-specific transcription factors located within the gene cluster and global regulatory factors regulate fungal growth, development, and secondary metabolite production, as exemplified by the VELVET family of regulatory proteins (VeA, VelB, LaeA, among others). In the present study, we have characterized the competitive ability of *veA* and *patK* deletion mutants against the wild-type strain and their effect on patulin production. The hypothesis is that during host infection, different fungal strains may compete for nutrients and space, and the non-mycotoxigenic strains may outcompete mycotoxigenic strains during colonization. This displacement between strains would not necessarily reduce the global rate of infection but could reduce the presence of mycotoxins and therefore the associated health risk. The present study shows that the deletion mutants displace the wild-type strain during *in vitro* growth and, consequently, there is a reduction in patulin levels. This preliminary study raises the possibility of using non-mycotoxin-producing strains of *P. expansum* as biocontrol agents.

Funding: RTI2018-093392-A-I00 (AEI/FEDER, UE), JAEIntro2019-CSIC (JAEINT_19_01896), PRE2019-089326 y RYC-2017-22009.

Keywords: *Penicillium expansum*, competitive ability, patK, veA, patulin

PP-7

Genetic diversity and pathogenicity of *Diaporthe* spp. causing hazelnut defects of hazelnut nuts from Italy

Muhammad Waqas[1], Alan Pizzinat[2], Vladimiro Guarnaccia[1,3], Davide Spadaro[1,3]

[1] DISAFA, University of Torino, 10095 Grugliasco, Italy. Email: davide.spadaro@unito.it
[2] Fondazione AGRION, Via Falicetto 24, 12030 Manta, Italy
[3] AGROINNOVA, University of Torino, 10095 Grugliasco, Italy

Abstract
The main hazelnut producing countries are Turkey, Italy, and the USA. In Italy, hazelnut is cultivated on over 80,000 ha, with a production of about 110,000 t. Hazelnut supply chain is increasingly affected by the phenomenon of rotten hazelnut, which includes a series of internal hazelnut defects such as browning and rot, which can be visible after cutting. In order to investigate and better understand the etiology of the hazelnut defects and the identification of the causal agents, surveys were conducted in 2020 in Piedmont, Northern Italy, historically area dedicated to hazelnut cultivation. A total of 383 fungal strains were isolated, from mouldy, necrotic or black rotted hazelnuts and 38.9% of the isolates were identified as *Diaporthe* spp. In particular, the incidence of *Diaporthe* spp. was much higher on mouldy hazelnuts (68.5%) than from hazelnuts showing black rots (14.8%) or necrotic spots (16.8%). A multi-locus phylogeny was established based on two genomic regions, ITS (ITS1/ITS4) and *tef-1α* (EF1-728F/EF1-986R) on 40 isolates of *Diaporthe* spp. Pathogenicity tests were performed on immature hazelnuts with the 40 isolates. Three nuts per isolate, and per three replicates, were surface disinfected with 1% NaClO. Nuts were wounded with a cork borer (5 mm diameter) and inoculated with mycelium plug cut from 7 days old PDA colony. Five species of *Diaporthe* were identified. Among the species identified, *D. eres* was the dominant one (75% of the isolates). Pathogenicity tests showed that the five species were pathogenic on hazelnut nuts, but *D. eres* was the most aggressive species. The present study improves our understanding of the epidemiology as well as the species associated with hazelnut defects and provides useful information for effective management of the disease.

Keywords: Hazelnut, phylogenesis, nut rot, *Diaporthe eres, Corylus avellane*

PP-8

Identification and pathogenicity of the causal agent(s) of black vein of Swede

Belachew Asalf, Juliana Perminow, Vinh Hong Le, Inger-Lise Akselsen, Berit Nordskog

Division of Biotechnology and Plant Health, Norwegian Institute of Bioeconomy Research (NIBIO), 1433 Aas, Norway. Email: belachew.asalf.tadesse@nibio.no

Abstract

Swede or rutabaga (*Brassica napus* L. var*. napobrassica* (L.)) is one of the few vegetables produced almost 100% domestically in Norway. After harvest and cold storage, the vascular bundles of the swede often turn brown to blackish and they become unmarketable. The causal agent for black vein is not known. When a plant shows symptoms suggestive of an infection, it is important to identify the causative agent to take appropriate control measures and reduce loss in quality and quantity of the product. In collaboration with the Norwegian Agricultural Extension Service, this study was conducted from 2018 to 2021 i) to determine the occurrence of black vein of swede in Norway, ii) to identify the causal agent(s) associated with the black vein symptom, and iii) to determine the pathogenicity of the identified fungi and bacteria. In the pathogenicity test a reference bacterium NCPPB 528 (*Xanthomonas campestris* pv. *campestris)* from NIBIO isolate collection was included. Bacteria isolated from symptomatic tissue were identified with the method called Fatty Acid Analysis, and fungi were identified morphologically and by DNA sequencing. The incidence of black vein ranged from 1% to 35% with a mean of 9.5%. Bacteria and fungi were identified from swede with black vein symptom. The fungi that were identified included *Plectosphaerella spp*., *Gibellulopsis nigrescens* (syn. *Verticilium spp*) and *Fusarium spp*.. Several bacteria were identified, but *Pseudomonas putida* was the dominant species. After cold storage for one-month, black vein symptoms were detected from all treatments including the uninoculated control swedes, but black vein incidence and severity were very high in swede inoculated with the reference bacteria isolate *Xanthomonas campestris* pv. *campestris.* Black vein symptom development after storage indicates the latent infection of the swede that start from field and progresses during the storage time.

Keywords: Swede, rutabaga, black rot, postharvest disease, black vein

PP-9

Diagnostic analysis of post-production losses of tomato (*Solanum lycopersicum*) in the Menoua division, West region of Cameroon

Henri Grisseur Djoukeng, Whitney Rakelle Anguezomo Assoumou, Nestor Lindou Peyoumeya

Department of Rural Engineering, University of Dschang, B.P. 222, Dschang, Cameroon. Email: hgdjoukeng@gmail.com

Abstract

The agricultural product supply chain from the field to the final consumer is subject of several losses. These losses, both qualitative and quantitative, known as postharvest losses are caused by several factors. In Cameroon, tomato (*Solanum lycopersicum*) is among the most important fruits with a consumption of about 35%. This study aims to reduce postharvest losses of tomato, contributing to increase the income and standard of living of fruit and vegetables producers, in the Menoua division. The study was conducted in two tomato production basins, namely Tsinfou and Litieu. The various postharvest technics adopted by producers, transporters and traders were identified through investigations and direct observations. The rate loss of tomato and its deterioration over a certain period of time were evaluated and interpreted. Also, the type, nature and causes of these postharvest losses were determined. The results from this study show that inappropriate post-harvest technics are practiced in all links of the supply chain. The rate loss during harvest, transportation, trading and conservation are 11.75%, 7.45%, 21% and 35.5% respectively. They are caused by factors as, mechanical action (impact of shocks and vibrations), biological and microbial action (predators, fungi, etc.), environmental and climatic factors (humidity, temperature, etc.) and socio-economic factors (impact of road infrastructure and non-government assistance). These losses reduce incomes and the availability of tomatoes on the market, hence their accessibility to poor citizens. To reduce these losses emphasis should be placed on a technical framework enabling stakeholders to better define the outline of appropriate techniques. Establishment of affordable processing and conservation units, government assistance, qualified workforce and maintaining a good state of roads should be adopted.

Keywords: Postharvest losses, supply chain, postharvest technics, handling

PP-10

Bacterial endophytes as a biocontrol agent against mycotoxigenic fungi of cereals

Vijay Kumar Sharma, Ajay Kumar, V. Yeka Zhimo, Shoshana Salim, Oleg Feygenberg, Edward Sionov, Samir Droby

Department of Postharvest Science, The Volcani Institute, ARO, Rishon LeZion 7505101, Israel. Email: vjsharma@outlook.in

Abstract

During postharvest storage, contamination of cereals, such as wheat and maize, by mycotoxigenic fungi affects the quality and producing toxic substances renders the grains unsafe for consumption. *Aspergillus flavus*, and *Fusarium proliferatum* are considered major contaminants of stored grains that are usually controlled by chemicals applied by fumigation. There is an urgent need for sustainable and ecologically safe approaches to manage mycotoxigenic fungi. In this work, we focused on isolation of endophytic microorganisms and testing their antagonistic activity against both mycotoxin-producing fungi. Results showed that among the isolated endophytic microorganisms, bacterial strains belonging to *Bacillus* spp. were found effective in inhibiting the growth of *A. flavus* and *F. proliferatum*, both *in vitro* and on grains. The fungal DNA was reduced by 70.5% and 89.7% for the wheat grains that were subjected to *A. flavus* suspension and pretreated with *B. subtilis* or *B. amyloliquefaciens*, respectively, as compared to the control. The fungal DNA was decreased by 41.6% and 62.7%, for the wheat grains that were subjected to *F. proliferatum* suspension and pretreated with *B. subtilis* or *B. amyloliquefaciens*, respectively, as compared to the control. In addition, their secondary metabolites exhibited antifungal activity against *A. flavus* and *F. proliferatum* in a disc diffusion assay. The highest zone of inhibition (21.5 mm) was exhibited was *B. subtilis* against *F. proliferatum* followed by 17 mm against *A. flavus,* while, *B. amyloliquefaciens* exhibited 21 and 18 mm zone of inhibition against *F. proliferatum* and *A. flavus*, respectively. Further research is needed to assess the mechanism involved.

Keywords: Endophytes, biocontrol, mycotoxigenic fungi, cereals

PP-11

Changes in gene expression and postharvest decay inhibition of papaya (*Carica papaya* L.) treated with chitosan and *Ruta graveolens* L. essential oil alone and in combination

Lucia Landi[1†], Yeimmy Yolima Peralta Ruiz[2,3†], Clemencia Chaves Lopez[2], Gianfranco Romanazzi[1]

[1] Department of Agricultural, Food and Environmental Sciences, Marche Polytechnic University, 60131 Ancona, Italy. Email: l.landi@univpm.it
[2] Faculty of Bioscience and Technology for Food, Agriculture and Environment, University of Teramo, 6 4100 Teramo, Italy
[3]Department of Agroindustrial Engineering, Faculty of Engineering, Universidad del Atlántico, 081008 Puerto Colombia, Colombia
[†] These authors contributed equally to this work

Abstract
Papaya (*Carica papaya* L.) is an economically important fruit crop in many tropical and subtropical countries, with fast maturation and high susceptibility to fungal diseases, with a consequent short shelf life. Chitosan (CS) coating has shown ability to control postharvest decay of fruits and can be a carrier of essential oil, like *Ruta graveolens* L. essential oil (REO). In this study the effects of CS and REO, alone and combined (CS-REO) on postharvest decay on papaya fruits during storage (9 days at 25°C) and the expression of key genes involved on defence mechanisms induced at 0.5, 6, 24, 48 and 72 hours post treatments (hpt), were evaluated. The REO and CS-REO emulsion reduced the papaya incidence decay by 21%, and 37%, respectively, and the disease severity by 22%, 29%, and 44% with CS, REO and, CS-REO treatments, respectively. The real-time quantitative polymerase chain reaction (RT-qPCR) was performed according to 17 key genes of papaya linked to signalling pathways regulating plant defence, pathogenesis-related protein, cell wall-degrading enzymes, oxidative stress, abiotic stress, and phenylpropanoid pathway. While the REO strongly induces overexpression in the early phase at 0.5 hpt, the CS affected the gene expression mainly starting from 6 hpt. The CS-REO treatment delays the genes up-regulation from 0.5 to 6 hpt compared to REO treatment and induce the genes up-regulation over time compared with other treatments. Our results suggest that CS help to immobilize the bioactive volatile substances of essential oils, releasing them more slowly and regulating the cell stress. This outcome highlights new information on the induction of defense reactions, that can be useful for the control of postharvest diseases of fresh fruit.
This work was conducted within the framework of the PRIMA StopMedWaste project, which is funded by PRIMA, a programme supported by the European Union.

Keywords: Antifungal activity, chitosan film, defense mechanism, essential oil, gene expression

PP-12

Molecular identification of *Monilinia laxa*, *Monilinia fructigena* and *Monilinia fructicola* from stone fruits in the Marche Region, Central-Eastern Italy

Sarah Mojela Makau, Annamaria L. D'Ortenzio, Valeria Mancini, Sergio Murolo, Lucia Landi, Gianfranco Romanazzi

Marche Polytechnic University, Department of Agricultural, Food and Environmental Sciences, Via Brecce Bianche, 60131 Ancona, Italy. Email: g.romanazzi@univpm.it

Abstract

Stone fruit are highly perishable fruits with short shelf-life exacerbated by susceptibility to postharvest decay, which lead to losses in major production areas worldwide and waste at consumer's home. Fungi belonging to the genus *Monilinia*, particularly *Monilinia laxa*, *Monilinia fructigena*, *Monilinia fructicola* and *Monilinia polystroma*, are well known causal agents of brown rot of stone fruit. These pathogens are most prominent in warm and humid climates, where they are able to overwinter in multiple sources of inoculum, causing blossom blight and brown rot. In the summer of 2018 and 2019, a survey study was carried out to investigate distribution of *Monilinia* species causing brown rot in peach and nectarine orchards and in packinghouses located in Ascoli Piceno, Fermo and Pesaro-Urbino provinces of Marche region, Central-Eastern Italy. Sampling was carried out on infected fruit and genomic DNA was extracted using the cetyltrimethylammonium bromide method. Molecular identification was performed by multiplex PCR using common reverse primer MO368-5 and three forward primers, namely Laxa-R2 to amplify *M. laxa*, MO 368-8R for *M. fructigena* and *M. polystroma*, and MO 368-10R for *M. fructicola*. PCR products were electrophoresed in 1.5% agarose gels in 1× TBE buffer, stained with GelRed dye and visualized under ultraviolet light. *M. laxa* was the most abundant species, found on fruit in all orchards and packinghouses. Presence of *M. fructicola* was observed in increasing frequency in the 2019 production season, while *M. fructigena* was not widespread on stone fruit. Knowledge on occurrence and distribution of the species will facilitate planning and implementation of management strategies. Further studies needed to investigate the degree of resistance of *Monilinia* species to synthetic fungicides used for their management.

This work was conducted within the framework of the PSR ZeroSprechi and of PRIMA StopMedWaste project, which is funded by PRIMA, a programme supported by the European Union.

Keywords: Brown rot, molecular identification, *Monilinia* spp., shelf life, stone fruit

PP-13

Mycotoxins' role in host tissue colonization by producing fungi

Simona Marianna Sanzani[1], Massimo Reverberi[2]

[1] Department of Soil, Plant and Food Sciences, University of Bari Aldo Moro, 70126 Bari, Italy. Email: sanzani@iamb.it
[2] Department of Environmental Biology, Sapienza University of Rome, 00185 Rome, Italy

Abstract

The biological role of mycotoxins remains unclear. It is believed that producing fungi might be better protected against organisms sharing the same trophic niche. However, some mycotoxins seemed to enhance fungal aggressiveness during host exploitation. For example, *Alternaria alternate* produces many toxic secondary metabolites, of which the most relevant is alternariol (AOH) and its derivative monomethyl ether (AME). Recently, the central role of the polyketide synthase gene *pksI* for the biosynthesis of AOH and AME has been established (doi:10.1111/mmi.14258). Moreover, the *pksI*-deleted *Alternaria* strain displayed reduced virulence on tomato, citrus and apple, suggesting AOH as virulence and colonization factor. A polyketide synthase is also the first step of the biosynthesis of the mycotoxin patulin, mainly associated to *Penicillium expansum*. The disruption of the 6-methyl-salicylic acid synthase allowed to obtain mutants that produced less patulin than their wild-type (WT) strain and showed a significantly reduced virulence on apples (doi:10.1016/j.ijfoodmicro.2011.11.021). When patulin was exogenously restored, mutants recovered their virulence as compared to that of the WT. Finally, mutants were susceptible to the antioxidant quercetin at 1/100 of the concentration needed for the WT. Finally, the quinone menadione was used as stressing agent for uncovering the molecular determinants driving *Aspergillus flavus* in challenging oxidative stress conditions by the host (doi:10.3390/toxins7104315). Metabolic and transcriptional analyses were conducted. Under oxidative stress conditions, *A. flavus* proved to activate several metabolic processes for limiting the ROS-associated detrimental effects, as well as for triggering adaptive and escape strategies, including aflatoxin B1 production. The results reported herein encourage investigation of mycotoxins from a plant pathologist perspective.

Keywords: *Alternaria, Aspergillus, Penicillium*, transcriptomic, pathogenicity

PP-14

A Sweet Battle- The effect of tomato fruit sugar level on the pathogenicity mechanism and host response during infection of two postharvest fungal pathogens

Carmit Ziv[1], Noa Sela[2], Arthu Schaffer[2], Dov Prusky[1]

[1] Department of Postharvest Science, The Volcani Institute, ARO, Rishon LeZion 7505101, Israel. Email: carmit.ziv@agri.gov.il
[2] Department of Plant Science, The Volcani Institute, ARO, Rishon LeZion 7505101, Israel

Abstract
Colletotrichum gloeosporioides and *Penicillium expansum* cause postharvest disease in tropical and deciduous fruits. During host colonization, *C. gloeosporioides* and *P. expansum* differentially modulate environmental pH and gene expression to enhance pathogenicity, as dependent on sugar availability in the host tissue. To uncover the effect of host sugar content on these pathogens' interactions with fruits we performed global transcriptomic and metabolomics study during *C. gloeosporioides* and *P. expansum* inoculation of two tomato lines having similar genetic background but differential level of total soluble solids (TSS) content: low sugar content (LowSC) and high sugar content (HighSC). *C. gloeosporioides* showed enhanced colonization of the LowSC line containing 7.33% TSS with enhanced relative expression of glycosyl hydrolases, glucanase and the major facilitator superfamily transporter genes. Enhanced colonization of *P. expansum* occurred in the HighSC lines with 12.23% TSS, accompanied by an increase in carbohydrate metabolic processes and glycolysis, mainly phosphoenolpyruvate carboxykinase, 2-oxoketoglutarate and the accumulation of gluconic acid. The host gene response to fungal attack differed depending on the sugar level. Reduced colonization of HighSC lines by *C. gloeosporioides* was accompanied by increased induction of glucosyltransferase expression, which regulates the activity of antifungal compounds such as phenylpropanoids, suggesting a new mechanism for modulation of fruit defense against pathogens. While the low sugar content lines downregulate carbon metabolic process and pathogenicity of *P. expansum*. Overall, host sugar levels in tomato fruits differentially modulate colonization patterns by activating specific fungus-pathogenic and host-response factors. This indicates a pivotal role of the dynamic changes in nutrient availability during fruit development and ripening in determining susceptibility to different fungal pathogens.

Keywords: Fungal pH modulation, induce pathogenicity, induced resistance, changes in fruit sugar, sugar level and pathogenicity, host pH modulation

PP-15

Microbiome shifts during the developmental stages from flowering to ready-to-eat mango fruit

Malick Bill, Lizyben Chidamba, Jarishma Keriuscia Gokul, Lise Korsten

Department of Plant and Soil Sciences, Natural and Agricultural Sciences, University of Pretoria, 0002, Hatfield, Pretoria, South Africa. Email: malickbill@gmail.com

Abstract

To understand microbial population shifts during mango fruit development (phenological stages) from flowering to ready-to-eat fruit and the significance of both physical and chemical interventions, responses of the fungal and bacterial communities on the anthoplane, fructoplane, stems and stem-end pulp of mango fruit were determined using next generation (Illumina) sequencing of the internal transcribed spacer (ITS1) and 16S regions. A total of 1,458,457 and 1,119,897 high-quality ITS and 16S sequences, respectively were generated. The inflorescence stage at full bloom had the richest fungal and bacterial communities while the young developing fruit had lower richness in comparison to the intermediate growth stage and fully developed fruit stages on the fructoplane. At the postharvest stage, lower fungal and bacterial richness and diversities were observed following prochloraz treatment both on the fructoplane and stem-end pulp. The phyla *Ascomycota* (52.8%) and *Basidiomycota* (43.2%) were the most dominant fungi, while sequences of the *Penicillium*, *Botryosphaeria*, *Alternaria* and *Mucor* were detected as the known postharvest decay causing fungal genera throughout the study period. The Cyanobacteria (35.6%), Firmicutes (26.1%) and Proteobacteria (23.1%) were the most dominant bacteria. Sequences of *Bacillus* including *B. subtilis* were detected as the dominant in the *Firmicutes phylum*. Postharvest interventions such as prochloraz had an effect on the presence of pathogenic fungal populations and *B. subtilis* populations. The current study provides important baseline data for further exploration of microbial population shifts in mango fruit that is possibly driven by chemical (pesticide) or physical (cold storage) interventions.

Keywords: Preharvest, non-target fungicidal effect, phytopathogenic fungi, phytobacteria, plant microbiome, endophyte

PP-16

Microbiome alteration in fruit following application of the yeast biocontrol agent *Metschnikowia fructicola*

V. Yeka Zhimo, Oleg Feygenberg, Shoshana Salim, Ajay Kumar, Vijay Kumar Sharma, Samir Droby

Department of Postharvest Science, The Volcani Institute, ARO, Rishon LeZion 7505101, Israel. Email: vyzhimo@gmail.com

Abstract

Numerous studies have been conducted about the use of microbial antagonists to control postharvest pathogens. However, relatively low number of reports are available regarding the impact of biocontrol agents on microbial communities residing in fruit. This study was undertaken to assess the implication of using biocontrol agents targeting postharvest decay on the fruit microbiome community. The yeast biocontrol agent *Metschnikowia fructicola* was applied on strawberry fruit in the field as near-harvest spray and microbial communities were assessed at the time of application, during harvest and after storage. High-throughput sequencing revealed that *M. fructicola* persisted in high relative abundance on the fruit surface after harvest and storage and caused significant shifts in the fruit surface microbial community. Microbial alterations included a decreased fungal diversity and an increase in bacterial diversity, significant shifts in composition and structure, differential enrichment of potentially beneficial microbial taxa and reduction in relative abundances of pathogenic genera especially *Botrytis* sp., leading to suppression of postharvest decay. Results of this study provide new insights into the dynamics of the postharvest fruit microbiome following the application of biocontrol agent that will assist in the development of a targeted, microbiome-driven approach to robust and sustainable disease control strategies.

Keywords: Microbiome, postharvest, strawberry, *Botrytis sp.*

PP-17

Unraveling plant responses triggered by *Botrytis cinerea* in strawberry fruit during ripening

Yijie Zhao[1,2], Maarten Hertog[2], Bart Nicolaï[1,3], Barbara De Coninck[1]

[1] Plant Health and Protection Laboratory, Department of Biosystems, KU Leuven, 3001 Leuven, Belgium. Email: yijie.zhao@kuleuven.be
[2] Division of Mechatronics, Biostatistics and Sensors, Department of Biosystems, KU Leuven, 3001 Leuven, Belgium
[3] Flanders Centre of Postharvest Technology, 3001 Leuven, Belgium

Abstract

Strawberry is one of the world's most popular fruit bearing crops. However, disease management is a never-ending challenge in strawberry cultivation. One of the most important diseases leading to substantial economic losses in strawberry cultivation worldwide is gray mold caused by the necrotrophic fungus *Botrytis cinerea*. Infection generally occurs via the flower after which the fungus stays quiescent until fruit are fully ripened. However, a complete picture of the mechanisms restricting *B. cinerea* growth in unripe strawberries is lacking since no systematic transcriptome/metabolome profiling has been performed from infected flowers until ripened fruit. Here, we inoculated strawberry flowers and followed up the *B. cinerea*-strawberry interaction at various levels during the different ripening stages. We confirmed, by quantification of *B. cinerea* DNA, that *B. cinerea* remained quiescent after flower inoculation, while the amount of *B. cinerea* DNA sharply increased at mature fruit stage. Next, we performed transcriptome and metabolome profiling using RNAseq and GC-MS, respectively on flowers, immature and mature fruit to investigate changes in gene expression and aroma components at different ripening stages after flower inoculation with *B. cinerea*. Genes involved in the defense response pathway, from recognition to a direct effect against the pathogen, were differentially expressed and mature fruit displayed stronger transcriptional changes compared to flowers and immature fruit. Moreover, most of the defense-related genes were upregulated in flowers and mature fruit but downregulated in immature fruit. Therefore, the induced defense response is not the main reason for limiting the growth of *B. cinerea* before strawberry maturation. Meanwhile, the expression of defense-related genes and the amount of volatile metabolites with antimicrobial functions decreased from immature to mature fruits in the absence of *B. cinerea* inoculation. We therefore suggest that basal immunity in immature fruit contributes significantly to resistance to *B. cinerea* compared to defense responses that keep *B. cinerea* quiescent.

Keywords: Strawberry, *Botrytis cinerea*, flower inoculation, quiescent infection, transcriptome, aroma profiling

PP-18

Using SIFT-MS to evaluate the quiescent infection of strawberry fruit by *Botrytis cinerea*

Yijie Zhao[1,2], Maarten Hertog[2], Bart Nicolaï[1,3], Barbara De Coninck[1]

[1] Plant Health and Protection Laboratory, Department of Biosystems, KU Leuven, 3001 Leuven, Belgium. Email: yijie.zhao@kuleuven.be
[2] Division of Mechatronics, Biostatistics and Sensors, Department of Biosystems, KU Leuven, 3001 Leuven, Belgium
[3] Flanders Centre of Postharvest Technology, 3001 Leuven, Belgium

Abstract

Botrytis cinerea is a devastating pathogen that can cause huge losses to strawberries during storage. However, this fungus usually infects strawberries through their flowers, but symptoms do not appear until fruit are fully ripened. A fast and sensitive method to detect and quantify the fungus is therefore needed. Changes in aroma were previously observed after inoculation of ripe strawberry and grape fruits with *B. cinerea*. One of these changes is an increase in 1-octen-3-ol, which is produced by *B. cinerea* and is a biomarker of *B. cinerea* infection. In this study, strawberry flowers were inoculated with *B. cinerea* to mimic the natural infection and aroma profiling, using Gas Chromatography – Mass Spectrometry (GC–MS) and Selected ion flow tube mass spectrometry (SIFT-MS) were performed using strawberries at different developmental stages and without symptoms. At the same time, quantitative polymerase chain reaction (qPCR) was used to quantify *B. cinerea* DNA. First, we found that qPCR showed false negative results when the amount of *B. cinerea* in strawberries was low. Then, we compared SIFT-MS with GC-MS for all samples and SIFT-MS with qPCR for samples containing large amounts of *B. cinerea*. It was found that SIFT-MS correlated well with both GCMS and qPCR data. Therefore, SIFTMS can be recommended as a candidate method for the detection and quantification of *B. cinerea* during quiescent infection. Subsequently, multivariate data analysis and compound identification were performed, and more ions and tentative corresponding compounds were detected as biomarkers of *B. cinerea* infection. Additionally, the tentative identity of the corresponding compounds suggests that volatile changes caused by *B. cinerea* infection may contribute to plant defense.

Keywords: Strawberry, *Botrytis cinerea*, Gas Chromatography – Mass Spectrometry (GC-MS), selected ion flow tube mass spectrometry (SIFT-MS), nondestructive detection

PP-19

The active role of *Botrytis cinerea* on Inoculated-tomatoes postharvest ripening: Physiological and proteomic approaches

Nikolaos Tzortzakis

Department of Agricultural Sciences, Biotechnology and Food Science, Cyprus University of Technology, Limassol, 3603, Cyprus. Email: nikolaos.tzortzakis@cut.ac.cy

Abstract

Botrytis cinerea is an unbearable postharvest threat with serious economic impacts. Necrotrophic *B. cinerea* can readily infect ripe fruit resulting with disease symptoms to be rapidly in progress. To unravel the mechanism by which tomato fruit opposes pathogen attack, we investigated the changes in quality-related attributes as a direct response (DR) or systemic response (SR) of infected tomatoes to the *B. cinerea.* Additionally, the SR of protein yield and composition were studied in fruit stored at 11 °C/90% relative humidity (RH) for one week. Fungal infection accelerated ripening with increased ethylene and respiration rates. Fruit softening, vitamin C and *β*-carotene content increase were associated with DR but not with the SR of the pathogen. Pathogen infection increased lipid peroxidation, causing the production of hydrogen peroxide and oxidative stress, as fruit activated both enzymatic and non-enzymatic mechanisms to trigger stress. *B. cinerea* increased up to 6.6% the protein yield and down-regulated at least 39 proteins. Proteins involved in fruit ripening, such as an ethylene biosynthetic enzyme, were increased in wound-inoculated fruit. Moreover, antioxidant proteins, such as ascorbate peroxidase-APX1 and superoxide dismutase-SOD, increased in infected tomatoes, as these proteins are involved in reactive oxygen species detoxification. Constitutively-expressed proteins tended to be either increased (chaperonin and malate dehydrogenase) or remained unaffected (dehydrin) by pathogen inoculation. Protein levels involved in the metabolism of carbohydrate, the pentose phosphate pathway, terpenoid and flavonoid biosynthesis were differently affected during the treatments. By enabling a better understanding of the fungal direct or systemic response on fruit quality and ripening through biochemical and proteome studies, we may improve the plant–pathogen interaction and complexity.

Keywords: Tomato fruit, gray mould, storage, proteomics, quality

PP-20

Functional analysis of putative effector-encoding genes from the post-harvest pathogen *Penicillium digitatum*

Víctor Silva-Alejandre[1], Elena Levin[2], Samir Droby[2], Luis González-Candelas[1], Ana-Rosa Ballester[1]

[1] Food Biotechnology Department, Institute of Agrochemistry and Food Technology (IATA-CSIC), Calle Catedrático Agustín Escardino 7, 46980 Paterna (Valencia) Spain. Email: ballesterar@iata.csic.es
[2] Agricultural Research Organization ARO, the Volcani Institute, Roshon LeZion 7505101, Israel

Abstract
Penicillium digitatum, the fungus responsible of green mould, is the major pathogen in citrus fruits during post-harvest under Mediterranean climate conditions. The objective of the present study was to increase our knowledge on the function of effector proteins. Effectors are small secreted proteins (< 350 amino acids) with high relative cysteine content, which interfere with host defence responses allowing pathogen's development. Combining previous transcriptomic data along different infection times of oranges infected by *P. digitatum* and a bioinformatics pipeline to predict potential effector genes in the *P. digitatum* genome, we selected two genes coding for unknown effectors according to their expression during infection process and to their possible biological function. We have also selected one gene coding for necrosis and ethylene-inducing peptide-like protein (NLP). Proteins of this family are highly conserved over all kingdoms of microorganisms and are directly linked to the necrosis-inducing ability. We will present the characterization of null mutants in those genes regarding the *in vitro* growth of *P. digitatum* and discuss their role on the virulence of *P. digitatum*.
Funding: FPI-MICINN PRE2019-084000 Program and RYC-2017-22009 (MICINN/AEI/FSE, UE) and AGL2017-88120-R Project (MCIU/AEI/FEDER, UE).

Keywords: Citrus fruit, effectors, postharvest pathology

PP-21

Postharvest application of natural compounds and biocontrol agents to control brown rot of stone fruit

Annamaria L D'Ortenzio[1], Giacomo Fava[2], Stefano Mazzoni[3], Paolo Acciarri[4], Luciano Baronciani[5], Gianni Ceredi[2], Gianfranco Romanazzi[1]

[1] Department of Agricultural Food and Environmental Sciences, Marche Polytechnic University, 60131 Ancona, Italy. Email: lucrezia-1991@hotmail.it
[2] Apofruit Italia cooperative company, Viale della cooperazione 400, 47522 Cesena, Italy
[3] Mazzoni Stefano farm, Contrada Molino Aso 6, 63069 Ascoli Piceno, Italy
[4] Acciarri farm, Via Aso 55, 63851 Fermo, Italy
[5] Baronciani Luciano & Marino farm, Via Lago Trasimeno 13, 61122 Pesaro, Italy

Abstract
Postharvest losses caused by fungal decay seriously affect globally fresh fruit production. The main pathogens causing postharvest disease on stone fruit are *Monilinia laxa, M. fructicola* and *M. fructigena*, causal agents of brown rot. The effectiveness of formulations based on natural compounds and biocontrol agents to manage brown rot on peach cultivars +5Tardibelle and Extreme 486 was tested. Commercial formulations of chitosan, sweet orange essential oil, *Bacillus subtilis*, *Aureobasidium pullulans*, COS-OGA and a mixture of thymol, geraniol and eugenol were applied by dipping fruit, using as a reference a synthetic fungicide (fludioxonil) and an untreated control. Fruits were immersed for 30 seconds in the solutions, then cold stored at 2°C respectively 7 days for the cultivar +5Tardibelle and 14 days for the Extreme 486, then exposed to shelf life. Brown rot evaluation at 3 and 7 day shelf life showed a significant reduction of disease incidence by fludioxonil. Among alternative compounds, tendency toward disease reduction on +5Tardibelle was observed with application of chitosan and of *B. subtilis*, and on Extreme 486 with application of *Aureobasidium pullulans*. A sensory quality assessment was carried out to evaluate aroma and taste. The results showed the highest preference for peaches treated with fludioxonil, describing them as sweeter and tastier, followed by mixture of thymol, geraniol and eugenol and *B. subtilis*. These results suggest that the application of alternative substances could contribute to the management of postharvest diseases of peaches. Additional trials are needed to adjust concentrations and treatment time to make significant progress toward replacement of synthetic fungicides.
This work was conducted within the framework of the PSR ZeroSprechi and of PRIMA StopMedWaste project, which is funded by PRIMA, a programme supported by the European Union.

Keywords: Alternative compounds, *Monilinia* spp., peach, postharvest, shelf life

PP-22

Effect of light intensity on ecophysiological parameters of *Monilinia* spp. and on brown rot development on stone fruit

Marta Balsells-Llauradó, Rosario Torres, Núria Vall-llaura, Carla Casals, Neus Teixidó, Josep Usall

Postharvest Program, IRTA, 25003 Lleida, Catalonia, Spain. Email: neus.teixido@irta.cat

Abstract

The development of brown rot, caused by the necrotrophic fungus *Monilinia* spp. in stone fruit in both the field and postharvest, depends, among others, on environmental factors. The effect of environmental factors such as temperature and relative humidity has been thoroughly studied. However, information on the physiological response of fruit and pathogen linked to light intensity has not been presented yet. We suggest that light intensity could act as a tool to modify both fruit mechanism defense and virulence factors of fungi. Therefore, our main objective was to report the effect of two light intensities (36W and 58W), used during the shelf-life period in postharvest, on pathological and physiological responses of nectarines infected by *Monilinia* spp. After inoculated fruit was exposed to both light conditions and darkness, we assessed brown rot development, ethylene production and respiration. Aggressiveness components such as incidence and lesion diameter revealed that the effect of light intensity in delaying or accelerating brown rot development was intrinsic to variety but also *Monilinia* spp. dependent. Moreover, the effect of light intensity on *in vitro* culture of *Monilinia* spp. was also evaluated. Light intensity promoted most of growth and development measurements of the pathogen growth under *in vitro* conditions, compared to darkness. Overall, we provide several pieces evidences of how light intensities modulate *Monilinia* spp. growth in both *in vitro* and on stone fruit infections. This study highlights the importance to manipulate light intensity as a potential strategy to modify brown rot development on stone fruit and to extent the shelf-life period of fruit in postharvest, market and consumer's house.

Keywords: Nectarine, postharvest, storage, light intensity, fungal aggressiveness

PP-23

The plant extracts as bio-fungicide against strawberry *Botrytis cinerea*

Alma Valiuskaite, Neringa Rasiukeviciute, Lina Dene, Simona Chrapaciene, Giedre Samuoliene, Akvile Virsile, Viktorija Vastakaite-Kairiene, Jurga Miliauskiene, Kristina Lauzike, Ruta Sutuliene, Ausra Brazaityte

Institute of Horticulture, Lithuanian Research Centre for Agriculture and Forestry, LT-54333 Babtai, Kaunas dist., Lithuania. Email: alma.valiuskaite@lammc.lt

Abstract

Botrytis cinerea causes yield losses and postharvest losses if gray mold is not controlled in the early production cycle. Despite the antifungal and antimicrobial activity, plant extracts have the potential for sustainable and green-trend plant protection. This study aimed to evaluate different plant extracts in various concentrations as a bio-fungicide against strawberry *B. cinerea*. The research carried out at the LAMMC Institute of Horticulture in Lithuania. In this study, selected plant extracts of *Syzygium aromaticum* and *Pimenta dioica* were used and extracts were obtained by CO_2 extraction. Fruits inoculated with *B. cinerea* and treated with extracts at the concentrations: *S. aromaticum* – 400 and 600 µL L^{-1}, and *P. dioica* – 1800 and 2000 µL L^{-1}. Disease incidence evaluated at 2, 6, and 10 days after inoculation, measured fruit firmness (N cm^{-2}) and soluble solids (°Brix). The results showed that plant extracts on postharvest strawberry fruits not so highly reduce disease incidence. However, the highest inhibition achieved by *S. aromaticum* 400 µL L^{-1}. The firmness of the control strawberries was a bit lower compared with treated with *S. aromaticum* 600 µL L^{-1} and *P. dioica* 2000 µL L^{-1}. In addition, the soluble solids content in the plant extracts was a bit lower than the control. Our results indicate that further research is needed; however, plant extracts are promising bio-fungicides against strawberry *B. cinerea*.

This project has received funding from European Regional Development Fund (project No 2.2-LMT-K-718-03-0035) under grant agreement with the Research Council of Lithuania (LMTLT).

Keywords: Gray mold, inhibition, *Syzygium aromaticum, Pimenta dioica*

PP-24

Effect of a zero-residue crop protection strategy on yield, fruit quality and pre- and post-harvest diseases of strawberries

Marco Garello, Giada Schiavon, Marco Rosati, Davide Spadaro

Department of Agricultural, Forest and Food Sciences and Centre of Competence AGROINNOVA, University of Torino, 10095 Grugliasco, Italy. Email: marco.garello@unito.it

Abstract

Growing concerns regarding environmental and health risks associated with synthetic pesticides residues, together with the adoption of a stricter legislation, are favouring the reduction of pesticide use in agriculture. A zero-residue crop protection strategy was developed and evaluated for the control of diseases of strawberries, in the field and during storage. Two trials were performed in two strawberry farms, located in northern Italy. The zero-residue crop protection strategy was compared to a conventional strategy. Data gathered in field for leaf spots and rotten stems showed no significant differences between the strategies in either farm. Similarly, analyses of total soluble solids, titratable acidity, firmness and colour, as well as yield, showed no difference between the strategies in either farm. Pesticide residue analyses showed undetectable levels of all the pesticides in the zero-residue fruit, except for fosetyl-Al, which has a long degradation time. Even after two years from the last application, the molecule was found in the fruit, though at low levels. Postharvest rots incidence was very low for both strategies in the farm adopting a high number of pesticide treatments, whereas a higher incidence was found in the zero-residue strategy (7%) compared to the conventional one (2%) in the farm adopting a low number of pesticide treatments. The fungi isolated from postharvest rots were mainly *Botrytis cinerea* (92%), followed by *Penicillium* spp. (7%) and *Colletotrichum* spp. (1%). Overall, this study showed that a zero-residue strategy has no negative repercussion on disease management and fruit quality, with the added benefit of a reduced residue amount in the final product.

Keywords: Pesticides residues, postharvest disease, fruit quality, strawberry, *Botrytis*

PP-25

Controlling `White haze´ disease under *in vitro* controlled conditions

Dario Angeli, Lorenzo Turrini, Fabio Zeni, Tomas Roman

Center for Technology Tranfer, Fondazione Edmund Mach, 38010, San Michele all'Adige (TN), Italy. Email: dario.angeli@fmach.it

Abstract

Epiphytic fungi colonizing the surface of apple fruits have cause severe damages in the last years in Northern Italy. The most important disease called "white haze" is cause by the agent *Tilletiopsis* sp. and consist of a thin whitish to grey layer of fungal growth sticking to the cuticle of apple surface in the field. The fungal growth may increase rapidly during the season and harvest time but no evidence of new symptoms and spread from infected to healthy apples was observed during storage. *In vitro* test with different chemical fungicides and new natural compounds were performed during 2020 and 2021 in order to determine their capability to reduce the fungal growth on Petri plate and design new effective control strategies in the field trial. Furthermore, the effect of UV-C treatment in reducing the growth of *Tilletiopsis* sp. in Petri plate was investigated. Results indicate the efficacy of chemical fungicide application ranged between 4 to 100% with the full control obtained by fosetyl-Al, captano, dodine and penconazole at 20 °C on PDA media. Interestingly, a full control of the pathogen was also obtained with a new natural compound based on orange oil extract but several others showed an acceptable control such as potassium bicarbonate, potassium phosphonate and acid clays whilst UV-C treatment do not inhibit the fungal growth of the pathogen at the tested conditions. These findings can help in designing new controlled strategies both in integrated and organic production in the field with the aim to reduce white haze symptoms during the season and preserve the fruit quality.

Keywords: Epiphytic fungi, white haze, apple, chemical control

PP-26

Contribution of light wavelengths to melanin biosynthesis in *Monilinia* spp. causes of brown rot in nectarine

Lucía Verde Yáñez, Josep Usall, Núria Vall-llaura, Neus Teixidó, Rosario Torres

Institute of AgriFood Research and Technology (IRTA) Fruitcentre, Postharvest Program, Lleida, 25003 Catalonia, Spain. Email: lucia.verde@irta.cat

Abstract

Monilinia spp. is the causal agent of brown rot in stone fruit. The development of the disease is influenced by different cellular responses based on the production of pigments that are not necessarily essential for the growth of the fungus but can contribute to survival and virulence in stressed conditions. The abiotic factor, light wavelength, is believed to affect the production of melanin biosynthesis, protecting the fungus against fruit defence mechanisms. Our study assesses the melanin content and the expression of genes involved in the melanin biosynthesis pathway (DHN) in the three main *Monilinia* species (*M. laxa*, *M. fructicola* and *M. fructigena*) under the effect of different wavelengths and darkness. After exposing *Monilinia* spp. to different wavelengths (white, black, blue, red and far-red) and darkness for 7 days, were immediately collected and frozen for analysis of melanin quantification and gene expression of the biosynthesis pathway. Our results show a phenotypic plasticity in the production of melanin in response to light. For instance, *M. laxa* produced a greater amount of melanin under black and white wavelengths, while in *M. fructicola* and *M. fructigena*, was under red wavelength. The analysis of 12 genes involved in the melanin biosynthesis pathway shows a different expression pattern both wavelengths and species. Based on our results, the influence of light on melanogenic genes has been demonstrated, contributing to conidia to be environmentally persistent.

This work was supported by project PID2020-115702RB-C22 from the Spanish Government by PhD grant PRE2018-085428 (L.V.-Y.) and the CERCA Programme/Generalitat de Catalunya.

Keywords: Abiotic factor, brown rot, pigments, postharvest

PP-27

Sensitivity of *Penicillium digitatum* and *Penicillium italicum* populations from citrus fruits in Chile to imazalil, fludioxonil and pyrimethanil

José Luis Henríquez, Ysadora Fernández, Marcelo Bustamante

Department of Crop Protection, Faculty of Agronomical Sciences, University of Chile, 8820000, Santiago, Chile. Email: jhenriqu@uchile.cl

Abstract

Blue and green mold caused by *Penicillium digitatum* (Pers.) Sacc. and *Penicillium italicum* Wehmer are among the most relevant postharvest rots of citrus fruits, impacting its commercialization. Postharvest control of these diseases in Chile has been mainly accomplished with synthetic fungicides with imazalil used for decades, but more recently, pyrimethanil and fludioxonil have also been used. This study was aimed to determine the sensitivity of a collection of both pathogens obtained from diseased citrus fruits, to the fungicides actually used by the Chilean citrus industry. Eighty nine isolates were obtained from lemons in a packinghouse facility after primary and secondary packing processes, where the fruit was treated once or twice (primary and secondary, respectively) with imazalil, pyrimethanil and fludioxonil. Lemons were originated from orchards located in the Metropolitan and O´Higgins Regions in central Chile. Other 15 isolates were obtained from clementines collected in a packinghouse located in the Coquimbo Region, in north-central Chile. The isolates were identified based on morphology and two representative isolates for species were identified by amplification of ITS (primers ITS1 and ITS4), followed by a restriction reaction with Mbo1, giving characteristic bands for each species. All isolates were grown as single-spore cultures and tested *in vitro* against the different fungicides in concentrations ranging from 0 to 100 µg mL^{-1}. Imazalil and fludioxonil were incorporated into potato dextrose agar, while pyrimethanil was tested in a minimal medium. The EC_{50} values for the inhibition of the mycelial growth were calculated by regressing the inhibition percentages against the logarithm of the fungicide concentrations. Population sensitivity fluctuated between 0.01 and 7.07; < 0.00001 and 3.92; and 0.003 and 11.07 µg mL^{-1}, for imazalil, fludioxonil and pyrimethanil, respectively. According to previously published discriminatory concentrations, an 18.3; 26.0 and 27.9% of the isolates were resistant to imazalil, fludioxonil and pyrimethanil, respectively.

Keywords: Green mold, blue mold, citrus postharvest rots, fungicide sensitivity

PP-28

An epiphytic basidiomycetous yeast as biocontrol agent of *Penicillium expansum*

Simona Marianna Sanzani[1], Michele Sgaramella[1], Saveria Mosca[2], Michele Solfrizzo[3], Antonio Ippolito[1]

[1] Department of Soil, Plant and Food Sciences, University of Bari Aldo Moro, 70126 Bari, Italy. Email: sanzani@iamb.it
[2] Department of Agriculture, Mediterranean University of Reggio Calabria, 89122 Reggio Calabria, Italy
[3] ISPA-CNR, Via Amendola 122/O, 70126 Bari, Italy

Abstract
Postharvest biocontrol agents are considered a viable alternative to the use of synthetic chemicals as demonstrated by extensive research conducted by scientists and companies worldwide. In the present investigation, the biocontrol potential of a carotenoid-producing basidiomycetous yeast isolated from table grape flowers was analysed. The strain RY1 proved to be *Sporobolomyces roseus*. *In vitro* and *in vivo* tests were conducted to assess its efficacy against *Penicillium expansum*, one of the most important postharvest pathogens and producer of the mycotoxin patulin. The yeast proved to control both fungal growth and patulin production, and, in addition, to greatly affect disease incidence and severity on apples. Its mode of action is presumably related both to the competition for nutrients and the production of antifungal volatiles. As such, although further large-scale trials are needed, our *S. roseus* strain represents a potential interesting biocontrol agent to be applied after harvest.

Keywords: Postharvest, mycotoxins, alternative control

PP-29

Improving microbiological quality and storage life of date fruit using gamma irradiation

Durray Shahwar[1], Roheena Abdullah [2], Zienab F R Ahmed[1]

[1] Department of Integrative Agriculture, College of Agriculture and Veterinary Medicine, United Arab Emirates University, Al Ain 15551, United Arab Emirates. Email: zienab.ahmed@uaeu.ac.ae
[2] Department of Biotechnology, Lahore College for Women University, 55110 Lahore, Pakistan

Abstract
Date fruit is a high value nutritional food, with an impressive list of essential nutrients, vitamins and minerals packed in the fruit. Raw food products are progressively being perceived as critical vectors for transmission of food pathogens. Huge quantitative and qualitative losses of food occur during long storage periods. Food irradiation is one of the few advanced technologies that address both food safety and quality by virtue of its ability to control foodborne pathogens without fundamentally influencing sensory or other organoleptic properties. Therefore, this study aimed to minimize the post-harvest loss and to extend the quality and safety of date fruit using gamma irradiation. Date fruit of 'Shareefa' cv. was exposed to gamma radiation at different doses at 0.5, 1, 2, 3, and 4 kGy using Cobalt 620 source, and its effect on microbial load, nutrient contents, and sensory properties was investigated. All irradiated and control samples were stored at ambient and refrigerated temperature (4 °C) for three months. The physical, microbial, and chemical properties (moisture, ash, protein, fat, fiber, carbohydrate and energy content) were evaluated. The 4 kGy treatment effectively reduced the microbial load as it reduced the fungal growth and completely inhibited the bacteria growth after three months of storage at 4 °C as compared to the control. No harmful or negative impact was observed on moisture, ash, protein, fat, fiber, carbohydrate, energy content, and sensory properties of the irradiated samples. These results imply that gamma radiation at 4 kGy is a safe, effective, and economical treatment and may have a potential for improving microbiological quality and storage life of date fruit.

Keywords: Shareefa, gamma irradiation, storage life, date fruit, microbiology

PP-30

The double face of *Butlerelfia eustacei* – a post-harvest pathogen or a potential biocontrol agent?

Selena Tomada, Greice Amaral Carneiro, Alberto Storti, Sanja Baric

Faculty of Science and Technology, Free University of Bozen-Bolzano, 39100, Bolzano, Italy. Email: stomada@unibz.it

Abstract

Butlerelfia eustacei is a fungal species belonging to the family *Atheliaceae*. The poorly characterized *B. eustacei* has been reported sporadically as a post-harvest pathogen on apple and pear fruits, whereas *Athelia* species have been widely documented as cold-tolerant spoilage fungi on various crops. During a survey conducted on stored apple fruits in South Tyrol (northern Italy), a single isolate of *B. eustacei* was recovered from rotten apples coming from integrated production. The phylogenetic placement of the novel *B. eustacei* isolate was based on DNA sequence analysis of the internal transcribed spacer region and by comparison to reference sequences contained in GenBank. A pathogenicity test, to prove Koch´s postulates, was performed on apple fruit and the symptoms were comparable to those produced by the *B. eustacei* reference strain CBS 381.80 and two other isolates maintained in the collection of the Westerdijk Fungal Biodiversity Institute (NL). The first reported *B. eustacei* isolate from South Tyrol was able to induce symptoms which might be attributable to the fisheye rot disease. On the other hand, because members of the closely related genus *Athelia* have also been shown to display biocontrol activity against pathogen of apple trees, further research into this direction was conducted with *B. eustacei*. Preliminary *in vitro* tests revealed that the isolate from South Tyrol was able to antagonise several plant pathogens (*e.g. Alternaria* spp., *Cadophora* spp., *Colletotrichum* spp., *Diplodia* spp.). These findings pave the way for further research, making *B. eustacei* an interesting fungal species from a biotechnological standpoint, with the potential for the discovery of novel enzymes and antifungal compounds.

Keywords: *Atheliaceae*, biocontrol, rotten apple, post-harvest diseases

PP-31

Nanoencapsulation of bioactive substances of aromatic and pharmaceutical plants for use in the production of: (a) biological foods & food supplements (b) animal health protection products (c) plant protection products

Konstantina Pasvanka[1], Stergios Tzimikas[2], Konstadina Papastavropoulou[1], Charalampos Proestos[1]

[1] Department of Chemistry, Laboratory of Food Chemistry, National and Kapodistrian University of Athens, Athens, Greece. Email: harpro@chem.uoa.gr
[2] Dioscurides IKE, Anarachy Ptolemaida, Greece

Abstract
The aim of this work was the production of essential oils and aqueous extracts from aromatic plants of Western Macedonia, the determination of total antioxidant capacity and total phenolic charge, investigation of modern processes of the concentration of aqueous extracts and utilization of by-products to produce plant protection final products. One of the major targets was the application of nanotechnology products in plant protection, for prevention and treatment of foliar pathogens in greenhouse crops and pests of stored products. The measurements for size and stability were performed with the DLS (Dynamic Light Scattering) technique were the nanoparticles size and the zeta potential was calculated. Last but not least nanotechnology products were produced for prevention and treatment of many zoonoses and / or increase in production especially for the animal kingdom (bees, fish). The antimicrobial, antifungal, antiparasitic action was studied.
Project was financed by The Operational Program Western Macedonia 2014-2020 of the European Commission with the C (2014) 10180 final / 18-12-2014 decision and is co-financed by both the European Regional Development Fund (ERDF) and the European Social Fund (ECB) at a rate of 80%, code no. ΔΜΡ1-0010874.

Keywords: Nanoparticles, plant protection products, antioxidants, bioactive compounds

PP-32

Preharvest application of natural compounds on postharvest quality and gray mold of strawberry

Antonios Chrysargyris[1], Razieh Rajestary[2†], Panayiota Xylia[1†], Gianfranco Romanazzi[2], Nikolaos Tzortzakis[1]

[1] Department of Agricultural Sciences, Biotechnology and Food Science, Cyprus University of Technology, 3603 Limassol, Cyprus. Email: a.chrysargyris@cut.ac.cy
[2] Department of Agricultural Food and Environmental Sciences, Marche Polytechnic University, Via Brecce Bianche, 60131 Ancona, Italy
† Authors equal contribution

Abstract

Strawberry is a perishable fruit, with a short shelf life after harvest due to quality degradation and the development of *Botrytis cinerea* (gray mold) and other secondary diseases. The efficiency of commercial compounds based on chitosan, phosphoric acid and micronutrients, as well as orange essential oil (EO) on the decay and quality of strawberry fruits, was investigated. The plant canopy was sprayed in the field and strawberry fruits were harvested three days after treatments. Gray mold infections were recorded daily for seven days during storage at room temperature (20 ^{o}C ± 1^{o}C) or after cold storage for 7 days at 4 ± 0.5 ^{o}C following by seven days shelf life. The qualitative parameters were recorded at harvest (initial day) and after three days at room temperature condition (*RT*-20 ^{o}C) or cold storage (*CS*-4 ^{o}C). The application of orange EO ('Priv-Am Plus) increased the antioxidant and flavonoid content at harvest, while a decrease was reported with three days of storage at *RT* (20 ^{o}C). At the same time, increased ethylene production and weight loss were observed during *CS* (4 ^{o}C), three days after harvesting. Interestingly, chitosan maintained fruit quality and it was effective in the control of postharvest decay. Our findings revealed that natural compounds can improve strawberry postharvest quality, with chitosan performing best in terms of maintaining quality and minimizing postharvest decay, so it can be suggested as a good alternative to synthetic fungicides for strawberry postharvest gray mold control.

Keywords: Chitosan, fruit quality parameters, orange essential oil, phosphoric acid, preharvest treatments

PP-33

Effect of postharvest treatment on physiological disorders of new apple varieties

Dario Angeli, Lorenzo Turrini, Fabio Zeni, Tomas Roman

Center for Technology Tranfer, Fondazione Edmund Mach, 38010, San Michele all'Adige (TN), Italy. Email: dario.angeli@fmach.it

Abstract

Traditional apple varieties are still in demand, but growers are weeding them out in favor of varieties which they say taste better, have crunchier texture and sell for a higher price. The success of new varieties will depend on its distinctiveness, consistence of quality and the efforts of those growing, packing and marketing it. New varieties offer enhanced quality often coupled with unique attributes but there are still many aspects that need to be investigated. Generally, apples are stored many months at low temperature under controlled atmosphere (CA) in order to reduce the metabolic rate. The storability of several new introduced varieties is, however, limited by physiological disorders occurring naturally during storage which seem to cause the main postharvest fruit losses. Here, we focused on new promising apple cultivar developed in different countries and grown in Trentino Alto Adige region (northern Italy). Little is known about their storage features. In our trials performed in 2019 and 2020, a complex of different physiological disorders were observed: superficial scald, flesh browning and browning of the skin and underlying flesh (soft scald & soggy breakdown). Here, we present the results of different postharvest treatments applied in order to avoid fruit injury, including ultra-low oxygen atmosphere conditions (ULO), 1-methylcyclopropene (1-MCP) application and management of storage temperature.

Keywords: Apple, storage, damages, disorders

PP-34

Will cannabinoids be the next antifungal agents against postharvest pathogenic fungi?

Danielle Duanis-Assaf[1], Mark Feldman[2], Dalia Maurer[1], Oleg Feygenberg[1], Raphael Mechoulam[3], Doron Steinberg[2], Noam Alkan[1]

[1] Department of Postharvest Science, Agricultural Research Organization, Volcani Institute, 7505001, Rishon LeZion, Israel. Email: danielle.assaf@mail.huji.ac.il
[2] Biofilm Research laboratory, The Hebrew University of Jerusalem, 9112002, Jerusalem, Israel
[3] Medicinal Chemistry Laboratory, The Institute for Drug Research, The Hebrew University of Jerusalem, 9112002, Jerusalem, Israel

Abstract

Postharvest loss is estimated at more than 40%. Pathogenic fungi cause a major part of this loss. The most effective treatment against postharvest diseases is fungicides. However, due to growing concern for their harmful influences, there is a need to develop new strategies to control postharvest pathogens. One of the major strategies to control postharvest decay is to identify natural compounds with antifungal properties. Phytocannabinoids, are natural lipid-soluble molecules that were extracted from *Cannabis sativa*. Although the most familiar cannabinoid is the psychotropic Δ^9-tetrahydrocannabinol (THC), many of the cannabinoids are non-psychotropic, among them cannabidiol (CBD) and cannabigerol (CBG). The benefit of Phytocannabinoids on human health has been studied for many years, however, in recent years there are growing studies on their antibacterial effect. In the current study, we aimed to investigate the effect of CBD and CBG on postharvest fungal pathogens. We found that CBD and CBG inhibit the growth of *Botrytis cinerea, Penicillium expansum,* and *Colletotrichum gloeosporioides* in a dose-dependent manner. In the study of their mode-of-action, we found that both CBD and CBG reduced the chitin content in *B. cinerea* cell wall, and changed the cell membrane fluidity and permeability. CBD treatment caused hyperpolarization to the mitochondria membrane, which resulted in increased fungal ROS levels. Thus, the tested cannabinoids were able to decrease gray-mold development on the harvested grape. Overall, this study results demonstrate the antifungal activity of CBD and CBG and their mode-of-action, and their potential to serve as antifungal agents against postharvest pathogenic fungi.

Keywords: Postharvest decay, cannabinoids, fungal pathogen

PP-35

Effect of calcium compounds *in vitro* on two fungal pathogens causing postharvest rots of pepper

Charles Krasnow, Carmit Ziv

Department of Postharvest Science, The Volcani Institute, ARO, Rishon LeZion 7505101, Israel. Email: charlesk@volcani.agri.gov.il

Abstract

Peppers are a major vegetable crop grown in Israel for export and local markets. Postharvest fruit rots caused by *Alternaria*, *Botrytis*, and other fungi are a primary concern for growers as they can develop suddenly in storage and reduce market value of the produce. Controlling fruit rots with fungicides is limited due to concerns over residues and fungicide resistance; environmentally friendly alternatives are needed. The objectives of this study were to determine the effect of three calcium compounds *in vitro* on *Alternaria alternate* and *Cladosporium cladosporioides*, a minor pathogen of peppers recently identified in Israel. The two fungi were cultured for 5-10 d on PDA at 20°C in constant darkness. Calcium oxide (CaO) and a commercial product containing 8.1% CaO and DPTA chelator at 0.1 M significantly reduced conidial germination of *Alternaria* and *Cladosporium* by 37% and 58%, respectively. At the high rate of 0.25 M of these compounds, germination was reduced by >79% for each pathogen. Sporulation from mycelial discs of the fungi was prevented by CaO and CaO-DPTA formulation at the high rates; Calcium chloride had minimal effect. In weak-PDA (1.2% PDA) amended with CaO-DPTA at both rates and CaO at the high rate, mycelial growth was completely prevented. Limited growth was observed for CaO-DPTA at the low rate although mycelia appeared swollen and distorted. Calcium chloride had no visible effect on these pathogens and growth was enhanced slightly at the low rate. In a separate study, mycelial growth of *Botrytis cinerea* on PDA amended with CaO at 0.1 M was not significantly reduced; however, the CaO-DPTA formulation reduced growth of the pathogen by 52.5 and 86.2% at 0.1 and 1.3 M, respectively. Greater reduction in growth was observed at 12°C than at 22°C. Future research will determine if postharvest dips of pepper fruits in calcium compounds can reduce disease severity in storage.

Keywords: *Alternaria*, pepper, *Capsicum*, fruit rot, postharvest

PP-36

Alternative methods for the control of the most resistant isolate of *Penicillium digitatum* to Imazalil isolated from mandarin fruits

Emilia Nuñez[1], Liliana Aragon[2], Andres V. Casas Diaz[2]

[1] Plant Pathology Department, Univ. Nac. Agraria La Molina, La Molina, Peru
[2] Department of Horticulture, Univ. Nac. Agraria - La Molina, Apdo. 12-056, Lima 12, Peru. Email: cda@lamolina.edu.pe

Abstract

Postharvest control of green mold (*Penicillium digitatum*) in citrus packing houses in Peru is mainly accomplished with the use of imazalil (IMZ) fungicide. The use of IMZ has increased the population of biotypes that are resistant to this fungicide. From a previous investigation, of 15 total isolates collected in W. Murcott and Nova discarded mandarin fruits from a packing house from Huaral – Lima, and based on a survival rate at 5 mL L^{-1} of IMZ, sporulation rate and decay degree in fruits and high germination performance, the most resistant strain was isolated. The objective of the present study was to evaluate the most effective method to control this highly resistant strain of *P. digitatum* to IMZ using *in vitro* and *in vivo* essays. In the *in vitro* trial, potato dextrose agar (PDA) was treated with "Impala" (Imz) at 5 ppm and 500 ppm, "Timorex Gold" (TG, essential oil of *Melaleuca alternifolia tea*) at 5 mL L^{-1}, "Serenade" (BS, *Bacillus subtilis*) at 7.5 mL L^{-1} and “Tricho D” (TD, *Trichoderma harzianum*) at 0.75 g L^{-1}. For the *in vivo* trial it was used Imz at 500 ppm, TG at 5 mL L^{-1}, BS at 7.5mL L^{-1} and TD at 0.75 g L^{-1}. Murcott mandarin fruits were sprayed with a drench treatment for 30 sec, once the fruits were dry, 10 µL of suspended conidia solution (1 x 10^6 conidia mL^{-1}, 1 mm deep) were used to inoculate each fruit. The best treatment for the *in vitro* trial was IMZ at 500 ppm, followed by Serenade with a control percentage of 88% and Timorex Gold with 61%. The best treatment for the *in vivo* trial was Timorex Gold, which delayed mold progression with a 35% control of sporulation on the 6th day and with a 45% control of decay on the 8th day. Results showed a way to design control trials using Timorex Gold (*M. alternifolia*) as an alternative method in order to develop an anti-resistance management of *P. digitatum.*

Keywords: Green mold, *Penicillium digitatum*, imazalil, *Melaleuca alternifolia*

PP-37

Antifungal activity of Apulian seaweed extracts

Annamaria Mincuzzi[1], Anna Lisco[2], Marika Caputo[1], Nunzio Dipierro[2], Antonio Ippolito[1], Antonella Bottalico[2]

[1] Department of Soil, Plant, and Food Sciences, University of Bari Aldo Moro, Via Amendola 165/A, 70126 Bari, Italy. E-mail: annamaria.mincuzzi@uniba.it
[2] Department of Biology, University of Bari Aldo Moro, Via Orabona 4, 70125, Bari, Italy

Abstract

Pomegranate (*Punica granatum* L.) yield losses due to postharvest fungal pathogens represent an important issue for Italian pomegranate industry. Main involved fungi belong to *Alternaria*, *Coniella*, *Colletotrichum*, *Aspergillus*, and *Penicillium* genera against which few or no specific control means are allowed in integrated and organic agriculture. In this regard, great interest is devoted to the search for eco-friendly alternative antifungal compounds. Seaweeds, especially Rhodophyta and Ochrophyta-Phaeophyceae, are well-known for production of bioactive compounds like polyphenols; indeed, they are already employed as fertilizers and biostimulants. Most of them are produced by oceanic genera as *Sargassum* and *Ascophyllum*, but our research focused on Mediterranean macroalgae easily available in the sublittoral zone. Tested species were *Halopithys incurva* and *Laurencia marilzae* within Rhodophyta division and *Codium vermilara* among green ones. Algal polyphenolic preparations, obtained by filtering acidified water-ethanol extracts, were early assessed for total polyphenols amount and then tested for antifungal properties in amended seaweed-extracts potatoes dextrose broth by using a microspectrophotometric assay. Fungal growth was measured at different time-point for each fungal isolate: *Alternaria alternata*, *Coniella granati*, *Colletotrichum acutatum sensu stricto*, *Aspergillus welwitschiae*, and *Penicillium glabrum*. Polyphenolic concentration in the three species ranged between 3 and 57 µg mL^{-1} of gallic acid equivalents. Except for *P. glabrum* at the tested concentration whole algal extracts completely suppressed conidial growth of all pathogens. Results suggest that growth inhibition may be related to qualitative features rather than quantitative ones and highlight the need of further trials to evaluate chemical composition and putative dose-effect.

Keywords: Pomegranate, postharvest diseases, seaweeds, algae, seaweeds extract, antifungal activity, polyphenols, alternative control, *in vitro* trial

PP-38

LED-light technologies for *Botrytis cinerea* inhibition

Neringa Rasiukeviciute, Alma Valiuskaite, Lina Dene, Simona Chrapaciene, Giedre Samuoliene, Akvile Virsile, Viktorija Vastakaite-Kairiene, Jurga Miliauskiene, Kristina Lauzike, Ruta Sutuliene, Ausra Brazaityte

Institute of Horticulture Lithuanian Research Centre for Agriculture and Forestry, LT-54333, Babtai, Kaunas dist., Lithuania. Email: neringa.rasiukeviciute@lammc.lt

Abstract

Strawberry growing in controlled environment agriculture (CEA) systems is expanding. *Botrytis cinerea* is one of the leading pathogens reducing yield and causing postharvest fruit gray mold. For plant growth and development in CEA systems, supplemental lighting is one of the most important factors. The light-emitting diodes (LED) have the potential to revolutionize lighting technology for fruit protection against pathogens. This study aimed to evaluate the effect of different LED-light wavelengths on strawberry *Botrytis cinerea.* The experiments were conducted in a greenhouse at the LAMMC Institute of Horticulture. Strawberry fruits inoculated with single-spore *B. cinerea* isolates were put under a monochromatic LED-light of royal blue 455 nm, blue 470 nm, cyan 505 nm, yellow 590 nm, and red 627 nm. The total photosynthetic photon flux density of each wavelength was 20±2 µmol $m^{-2}s^{-1}$. Our results indicate that the highest inhibition of *B. cinerea* growth was achieved under red 627 nm and royal blue 455 nm LED-light. In addition, cyan 505 nm LED-light increased strawberry *B. cinerea* infection at 3 days post-inoculation. We assume that more studies on LED-light for strawberry fruits diseases control should be done to prepare plant protection technology. However, *B. cinerea* control by LED-light could be an innovative tool for disease control.

This project has received funding from European Regional Development Fund (project No 2.2-LMT-K-718-03-0035) under grant agreement with the Research Council of Lithuania (LMTLT).

Keywords: Gray mold, wavelengths, diseases, control

PP-39

Ripe indexes, hot water treatments, and biocontrol agents as synergistic combination to control apple bull's eye rot

Alessandra Di Francesco[1,2], Nicola Placì[1], Beatrice Scialanga[1], Gianni Ceredi[3], Elena Baraldi[1]

[1] Department of Agricultural Sciences, University of Bologna, 40057, Bologna, Italy. Email: alessand.difrancesc3@unibo.it
[2] Department of Agricultural, Food, Environmental and Animal Sciences, University of Udine, 33100, Udine, Italy
[3] Apofruit Italia cooperative company, Viale della cooperazione 400, 47522 Cesena, Italy

Abstract
Da-meter hand-held instrument, hot water (HW) treatment, and biocontrol agents (BCAs) represent an alternative solution to synthetic fungicides. In the present study, the three strategies were combined to reduce *Neofabraea vagabunda* virulence on apple fruit cv 'Cripps Pink'. *In vitro* assays were conducted by testing different heat treatments timing (10, 5, and 3 min at 45 °C) influence on pathogen mycelial growth together with BCAs (*Aureobasidium pullulans* L1 and L8, and *Trichoderma harzianum* Th1). The combined activities of HWT 45°×5 min and both BCAs volatile and no-volatile compounds displayed the complete control of the pathogen. *In vivo,* DA-meter was used to measure the index of absorbance difference (IAD) of chlorophyll-α content on apple, and to separate fruit in two different ripening classes, immediately wound inoculated with *N. vagabunda* conidial suspension, and treated with HW and BCAs. *In vivo* results showed how the combined action of HW and BCAs completely inhibited the pathogen. Also, the less ripe apple class showed a decrease of fungal incidence by 16.2% concerning the riper class. At harvest and after 4 months of storage at 0 °C, quality parameters of both apple classes heat-treated and untreated, such as firmness (FF), soluble solid contents (SSC), and pH were measured without showing any substantial differences. Obtained results open new perspectives on organic apple productions.

Keywords: Da-meter, heat treatments, BCAs, *Neofabraea vagabunda*, quality parameters

PP-40

Non-thermal plasma as a new alternative technology for effective control of postharvest fungal pathogens

Palma Rosa Rotondo[1], Caterina Rotolo[1], Paolo Francesco Ambrico[2], Marianna Ambrico[2], Donato Gerin[1], Stefania Pollastro[1], Francesco Faretra[1], Rita Milvia De Miccolis Angelini[1]

[1] Department of Soil, Plant and Food Sciences, University of Bari Aldo Moro, 70126, Bari, Italy. Email: ritamilvia.demiccolisangelini@uniba.it
[2] Institute for Plasma Science and Technology, National Research Council, 70126, Bari, Italy

Abstract

Several techniques can be used to preserve the quality of fruits and vegetables during postharvest storage. Non-thermal plasma, also known as cold plasma, and Plasma Activated Water (PAW) are currently proposed as novel promising tools against microbial contamination of produce, including major fungal pathogens responsible for postharvest decay. Atmospheric air plasma consists of a mixture of electrons, ions, radicals, stable and short living products, such as reactive oxygen and nitrogen species (RONS), and ultraviolet radiation. PAW is enriched in terms of RONS and could be successfully applied during postharvest stages. The effects of both direct and indirect applications of plasma on conidial germination of *Botrytis cinerea*, *Monilinia fructicola*, *Aspergillus carbonarius*, *Penicillium italicum*, *Penicillium digitatum*, and *Alternaria alternata* were evaluated using different plasma sources, *i.e.* Surface Dielectric Barrier Discharge (SDBD), Atmospheric Pressure Plasma Jet (APPJ), Volume Dielectric Barrier Discharge (VDBD). The complete spore inactivation was obtained after few seconds (VDBD) or minutes (SDBD and APPJ) of exposure. The efficacy of PAW was proved stable in its inhibitory effect for all the tested species with a persistence of at least 30 min after water activation. Major structural damages to conidia surface after plasma treatment were assessed by Scanning Electron Microscopy (SEM) analysis. An early etching and later perforation of cell walls up to complete cell disruption was observed. A decrease in viability of conidia and an increase in their membrane permeability was assessed by fluorescence-based assays. Differences in fungal sensitivity to plasma were observed, with *A. carbonarius* and *A. alternata* showing the lowest sensitivity to the treatments. Experiments on cherry fruits artificially inoculated with *B. cinerea* and *M. fructicola* and exposed to SDBD plasma demonstrated that the application of cold plasma on fruits may significantly extend their shelf life by direct inactivation of fungi and possible activation of plant defense responses.

Keywords: Dielectric Barrier Discharge, disease control, fungi, low-temperature plasma, mould

PP-41

The efficacy of conventional postharvest treatments on *Rosmarinus officinalis* shelf life

Constantinos Stefanou, Panayiota Xylia, Antonios Chrysargyris, Nikolaos Tzortzakis

Department of Agricultural Sciences, Biotechnology and Food Science, Cyprus University of Technology, 3603 Limassol, Cyprus. Email: c.stephanou79@gmail.com

Abstract

Rosmarinus officinalis is a well-known medicinal plant, used in the food industry as herb or a natural preservative, however, limited information for its postharvest preservation is available. This study aims to find a natural way of preserving fresh rosemary in order to increase shelf or/and storage life. Rosemary batched were dipped in distilled water (control), H_2O_2 10 g L^{-1} or 20 g L^{-1} for 1 min, ethanol 30% or ethanol 50% for 10 s or subjected to low O_2 for 30 min or for 1 h. Quality related parameters were observed during or at the 10th day of storage at 6 ^{o}C, including sensory evaluation, respiration rate, phenols, ascorbic acid, antioxidants, flavonoids and natural microflora. Application of ethanol 50% increased weight loss on the 10th day, whereas, on the 2nd day, application of low O_2 (30 min or 1 h) had higher weight loss rate in comparison to the other treatments. Respiration rate increased with the ethanol 30% application in comparison with the rest of the treatments (except low O_2 for 1 h). Moreover, ethanol 50% had the lowest respiration rate from all seven treatments on the 10th day of storage. Total variable counts of rosemary were significantly lower with the 30% or 50% ethanol application compared to H_2O_2 10 g L^{-1}, on the 10th day of storage. Furthermore, ethanol (30% and 50%) application decreased yeasts and molds in comparison with the other treatments. In addition, the application of low O_2 30 min treatment led to the most marketable and aromatic product after the control. Overall, the low O_2 30 min treatment appears to be the best postharvest method for the preservation of fresh rosemary followed by H_2O_2 10 g L^{-1}. Further investigation for postharvest methods in herbs could include ozone exposure, high CO_2, temperature and use of essential oils.

Keywords: Rosemary, postharvest quality, preservation, hydrogen peroxide, ethanol, low oxygen (hypoxia)

PP-42

Use of nitric oxide as a strategy for postharvest controlling blue mold in 'Cripps Pink' apples

Paulo Sérgio Gularte[1], Felix Büchele[2], Janaiana Catarina da Silva[1], Samara Martins Zanella[1], Rachael Maree Wood[2], Cassandro Vidal Talamini do Amarante[1], Daniel Alexandre Neuwald[2], Cristiano André Steffens[1]

[1] Department of Agronomy, State University of Santa Catarina, 88520-000, Lages, Brazil
[2] Competence Centre for Fruit Growing, at Lake Constance, 88213, Ravensburg, Germany. Email: felix.buechele@kob-bavendorf.de

Abstract
Blue mold, caused by *Penicillium expansum*, is responsible for considerable economic losses during the storage and marketing of apples. The aim of the present study was to evaluate the effect of nitric oxide (NO) on the blue mold and ripening of 'Cripps Pink' apples. Fruit were placed in hermetically sealed glass jars and injected with 0, 5, 10, 50 or 100 µL L^{-1} of NO. Fruit were exposed daily to NO for two hours in normal atmosphere. Apples were either inoculated (for blue mold evaluation) with 10 µL *P. expansum* spore suspension (10^6 spores per mL) or left untreated [for ripening assessment (flesh firmness, background skin color and titratable acidity)]. Fruit remained under ambient conditions (21 ± 1°C and 63 ± 5% RH) for 7 (inoculated apples) and 14 (uninoculated apples) days of shelf life. The experiment was carried out using a completely randomized design, with four replications of 10 apples. NO applications of 10, 50 and 100 µL L^{-1} reduced the severity of blue mold in 'Cripps Pink' apples and had a higher flesh firmness and titratable acidity than the 0 and 5 µL L^{-1} NO treatments. There was no effect of NO application on the background skin color. The postharvest application of nitric oxide may be a viable alternative for the control of blue mold and delay ripening of 'Cripps Pink' apples.

Keywords: *Malus* x *domestica* Borkh., Pink Lady®, *Penicillium expansum*, postharvest disease, ripening delay

PP-43

Incidence of physiological and pathogen related storage disorders in three apple varieties under different storage methods

Felix Büchele[1], Fabio Rodrigo Thewes[2], Daniel Alexandre Neuwald[1]

[1] Competence Centre for Fruit Growing, at Lake Constance, 88213, Ravensburg, Germany. Email: felix.buechele@kob-bavendorf.de
[2] Federal University of Santa Maria, 97105-900, Santa Maria, Brazil

Abstract
A variety of biotic and abiotic factors can promote the development of physiological and pathogen related storage disorders in apple fruit. Nowadays, apples are stored in controlled atmosphere settings to delay senescence and consequently reduce quality loss postharvest. This study was conducted to investigate the effect of various storage regimes such as RA (regular air), CA (controlled atmosphere), DCA-CD (dynamic controlled atmosphere) and DCA-CD with variable room temperature, each with and without 1 methylcyclopropene (1 MCP) application, on the development of storage disorders in 'Red Prince', 'Jonagold' and 'Pinova' apples. Fruit health was assessed after 4 and after 8 months with an additional week under shelf-life conditions in both instances, to simulate disorder emergence during a marketing period. All treatments maintained a high percentage of healthy fruit in the tested varieties for the shorter storage time. Disorder incidences increased with longer storage duration, especially in the following simulated shelf life period. Generally highest incidence of disorders was seen in fruit stored under RA, presumably related to advanced maturing. Storage under CA or either DCA technology significantly improved healthy fruit amount. However, cases of flesh and core browning were observed in DCA stored fruit which may be related to the low pO_2 established. Usage of 1 MCP increased the percentage of healthy fruit, although the effect was more pronounced in RA than in CA or DCA. The tested varieties showed individual susceptibilities to fungal pathogens, with increased cases of storage scab in 'Jonagold' and *Neofabraea spp*. rot in 'Pinova'.

Keywords: *Malus* x *domestica*, dynamic controlled atmosphere, 1-MCP, rots, shelf life

PP-44

Postharvest strategies for controlling fungal pathogens during storage of organically grown `Topaz´ apple

Daniel Alexandre Neuwald[1], Rachael Maree Wood[1], Ricardo Bauer Pilla[1], Adriano Arriel Saquet[2], Felix Büchele[1], Bruno Pansera-Espíndola[3], Denise Schmidt[4]

[1] Competence Centre for Fruit Growing, at Lake Constance, 88213, Ravensburg, Germany. Email: neuwald@kob-bavendorf.de
[2] Federal Institute of Education, Science and Technology Farroupilha, 98280-000, Panambi, Brazil
[3] Federal Institute of Education, Science and Technology Catarinense, 88965-000, Santa Rosa do Sul, Brazil
[4] Federal University of Santa Maria, 98400-000, Frederico Westphalen, Brazil

Abstract
Postharvest fungal rots are one of the main limiting factors during the long-term storage of apples, particular for organically grown fruit. Therefore, this study investigated the efficacy of different postharvest treatments in reducing fungal rot and maintaining fruit quality during controlled atmosphere (CA) and regular air (RA) storage of organically grown 'Topaz' apple. Fruit harvested in October 2020 from the Lake Constance region, Germany, were subjected to hot water (HW) dipping at 53 °C for 2 min; HW plus 8% calcium chloride ($CaCl_2$), HW plus 12% $CaCl_2$; HW plus 4% sodium bicarbonate ($NaHCO_3$); a fungicide pyrimethanil dipping (PENBOTEC™); and left untreated (untreated control; UTC). Fruit were then stored at 1°C under RA and CA (1 kPa O_2 plus 2.5 kPa CO_2) for four and six months, respectively. Under both storage systems, the postharvest treatments significantly reduced the fungal rot incidence compared to the UTC, excluding HW+12% $CaCl_2$ under CA-storage. HW plus $NaHCO_3$ had a significantly lower decay incidence than the other treatments under both storage systems. However, these fruit had high rates of corrosion and skin damage, and thus, fruit treated with HW+$NaHCO_3$ did not have the highest healthy fruit percentage. 'Topaz' apple treated with pyrimethanil and HW had a significantly higher healthy fruit percentage than the other treatments under both storage systems. There was no difference in healthy fruit and fungal decay percentage between storage systems. In contrast, CA-stored fruit maintained better overall quality than RA-stored fruit. Under RA, the HW+$CaCl_2$ treatments maintained a higher fruit firmness and titratable acidity during storage than the other treatments, while there was no difference in these quality parameters among treatments under CA-storage. These results demonstrate that postharvest hot water dipping at 53 °C and pyrimethanil application can reduce the incidence of fungal rot and maintain fruit quality during CA- and RA-storage in organically produced 'Topaz' apple.

Keywords: *Malus domestica*, calcium chloride, controlled atmosphere, fruit quality, fungicide, Pyrimethanil, hot water dipping, sodium bicarbonate

PP-45

Reducing post-harvest losses in organic beetroot production in Switzerland

Pascale Flury[1], Clémence Boutry[1], Patricia Schwitter[1], Martin Koller[2], Anja Vieweger[1], Hans-Jakob Schärer[1]

[1] Crop Sciences, Research Institute of Organic Agriculture, 5070, Frick, Switzerland. Email: clemence.boutry@fibl.org
[2] Innoplattform Bio GmbH, Moosgasse 34, 3210 Kerzers, Switzerland

Abstract
The market for organically produced vegetables in Switzerland is rapidly growing. Beetroot is especially popular. However, their storage until spring has become increasingly difficult in recent years, and losses due to post-harvest rots can now reach over 50% by March. Therefore, most organic beetroot that are sold in spring need to be imported. The causes for the various storage rots in beetroot in Switzerland are currently unclear and therefore there are few measures to prevent them in organic production. Infections with pathogens causing storage rots in beetroot can occur via the seed, in the field or post-harvest. Understanding the process of infection is therefore critical to finding solutions for prevention. Here, we present first results of a project aiming at reducing post-harvest losses in organic beetroot production. In a combination of on-farm field experiments and laboratory analyses, we aim to elucidate the causes of storage rots in organic beetroot and develop measures to improve storability. A first analysis of stored beetroot in February 2021 revealed that the predominant pathogens in Switzerland are *Fusarium* species and *Phoma betae*. Moreover, we found *Botrytis cinerea*, *Rhizoctonia solani* and *Pythium* sp. as causative agents of storage rots. In summer 2021, we started field trials in cooperation with four producers of organic beetroot where we monitored the production from sowing to storage. We compared different measures such as steam sterilization of the seed, the use of biocontrol products in the field, variety differences, or processing and cooling methods after harvest. The various measures were found to affect seed health, seedling emergence, and/or leaf health. Effects on storage rots are evaluated in March 2022.

Keywords: Beetroot, storage rots, biocontrol, on-farm field trial, organic

PP-46

Qualitative analyses and antifungal prospective of pomegranate juices and waste

Annamaria Mincuzzi[1], Graziana Difonzo[1], Davide Campobasso[1], Marika Caputo[1], Pasquale D'Ambrosio[1], Rosalinda Surico[2], Carmine Summo[1], Antonio Ippolito[1]

[1] Department of Soil, Plant, and Food Sciences, University of Bari Aldo Moro, Via Amendola 165/A, 70126 Bari, Italy. E-mail: annamaria.mincuzzi@uniba.it
[2] Masseria Fruttirossi Srl, Contrada Terzo Dieci, snc, 74011 Castellaneta, Ta, Italy

Abstract
Worldwide pomegranate cultivated area is greatly expanding because of great demand related to its nutraceutical and cosmeceutical properties. Biotic diseases, mainly caused by fungi, and abiotic damages limit their quality and yield. Both latent infections due to fungal pathogens, as *Botrytis cinerea*, *Alternaria* spp., *Colletotrichum* spp., and *Coniella granati*, and infections due to wound pathogens, as *Aspergillus* spp. and *Penicillium* spp., are responsible of postharvest losses. The few allowed control means are not enough to support this industry from the field until harvest and processing, especially concerning organic orchards. In Apulia region, leading pomegranate producer in Italy, fruit are locally processed creating waste related to juice production (discarded rind and seeds) and also faulty packaged juices obtained by pasteurization and pascalization. Assessment of polyphenolic content and antifungal properties of pasteurized and pascalized faulty juices and juice-extraction waste were the main aims of this research. Pomegranate products were evaluated for total anthocyanins and polyphenols detected by HPLC-DAD and for *in vitro* antifungal activity to control the growth of the above-mentioned fungi. Analyses pointed out a lower amount of polyphenols and anthocyanins in pasteurized juice than in pascalized juice, in which anthocyanins were 10-fold higher; anthocyanins and polyphenols were further detected in the waste extract. Concerning the effect of pomegranate products on pathogens, the results showed that pascalized juice was effective in reducing their growth, especially if added to the media after sterilization, as compared to addition to the media before the thermic treatment, highlighting a possible effect of both chemical and microbial properties. Further trials are in progress to confirm these promising preliminary data.

Keywords: Pomegranate, postharvest diseases, antifungal activity, alternative control, polyphenols, anthocyanins, pomegranate juices, pascalization, pasteurization, pomegranate waste

PP-47

Effect of CMC-Beeswax composite edible coating amended with antifungal agents on physicochemical proprieties of nectarine fruits during cold storage

Marwa Moumni[1], Ibtissem Hannachi[2], Hajer Ben Amara[2], Gianfranco Romanazzi[1], Mohamed Bechir Allagui[2]

[1] Department of Agricultural, Food and Environmental Sciences, Marche Polytechnic University, 60131 Ancona, Italy
[2] Laboratory of plant Protection, National Institute for Agronomic Research of Tunisia, University of Carthage, rue Hedi Karray, 2080 Ariana, Tunisia. Email: allagui.bechir@gmail.com

Abstract
Edible coatings maintain fruit and vegetables integrity as well as shelf life against bruising, tissue damage and, in general, physical injury caused by pressure, vibrations, and other mechanical factors. Researches on postharvest coating are steadily increasing towards new coating formulations based on biopolymers such as polysaccharides and proteins. These edible coatings should be safe to meet consumer's interest in health and nutrition. Carboxymethylcellulose (CMC) (0.5%), beeswax (0.2%), sodium bicarbonate (0.5%) and potassium sorbate (1%) were formulated as edible coating for postharvest fruits of Snow Queen' nectarine (*Prunus persica* var. nucipersica). These coated fruits inoculated with *Alternaria alternate* were stored at 10 °C during one month before assessing physiochemical and sensory criteria. Results showed that the edible coating reduced significantly lesions produced by the fungus delaying changes in color, firmness and minimized weight loss of nectarine fruits. The results demonstrated the potential of selected edible coatings containing salt GRAS (Generally Recognized As Safe) to extend postharvest life of fresh nectarine fruits, although further studies should focus on improving some properties of the coatings to enhance gas barrier and storability.
This work was conducted within the framework of the PRIMA StopMedWaste project, which is funded by PRIMA, a programme supported by the European Union.

Keywords: *Alternaria alternata*, edible coatings, nectarine fruits, physiochemical properties

PP-48

Antifungal edible coatings to control Alternaria black spot and maintain the quality of 'Rojo Brillante' persimmon during cold storage

Asunción Fernández-Catalán, Lluís Palou, Verónica Taberner, Amparo Grimal, Maricruz Argente-Sanchis, Maria B. Pérez-Gago

Postharvest Technology Center, Valencian Institute of Agricultural Research (IVIA), 46113 Moncada, Spain. Email: perez_mbe@gva.es

Abstract

Spain is the second persimmon producing and main exporting country in the world, and 'Rojo Brillante' is the most important cultivar. Nowadays, the main interest of the Spanish persimmon industry is to extend the marketing period to reach off-season markets and technologies such as 1-methylcyclopropene in combination with cold storage are being used to reduce chilling injury and maintain fruit firmness. However, 'Rojo Brillante' persimmon is quite susceptible to postharvest Alternaria black spot, caused by *Alternaria alternata*. In recent years, the development of edible coatings formulated with non-contaminating antifungal ingredients, such as some organic and inorganic salts authorized as food additives or GRAS ('generally recognized as safe') substances, has emerged as an alternative to extend the shelf life of fresh fruits and vegetables. In this work, composite edible coatings based on hydroxypropyl methylcellulose (HPMC) and beeswax (BW) were formulated with potassium bicarbonate (PBC) at 2.0% (w/w) or sodium ethyl paraben (SEP) at 0.1% (w / w) as antifungal ingredients and were applied to 'Rojo Brillante' persimmons previously inoculated artificially with *A. alternata*. Coated fruit were incubated at 20 ºC for 12 days, at which time the incidence and severity of the disease were evaluated. The effect of the coatings on fruit weight loss, firmness and respiration was evaluated on non-inoculated fruit after 15 and 30 days of storage at 1 ºC followed by a shelf-life period of 7 days at 20 ºC. The coating containing 0.1% SEP was the most effective to control black spot, with reductions of disease incidence and severity after 12 days at 20 ºC of 50 and 65%, respectively. Since this HPMC-BW-SEP coating also reduced weight loss, maintained firmness, and reduced CO_2 production of cold-stored persimmons, it showed potential as a commercial treatment to extend the postharvest life of 'Rojo Brillante' persimmon by reducing black spot and chilling injury.

Keywords: *Alternaria alternata*, disease control, postharvest quality, Diospyros kaki, GRAS substances

PP-49

Ozone as an alternative method to control postharvest diseases on strawberries

Séverine Gabioud Rebeaud, Véronique Varone, André Ançay, Danilo Christen

Research Division 'Plant Production Systems', Agroscope Research Center, 1964 Conthey, Switzerland. Email: severine.gabioud@agroscope.admin.ch

Abstract

Strawberries are popular fruit mainly appreciated for their red color, sweet taste, and fruity flavor. However, they suffer from a short shelf life principally due to the development of fungal diseases and sensitivity to mechanical damages. Strawberries are therefore generally commercialized rapidly after harvest to limit high fruit losses, although retailers and consumers are nevertheless regularly confronted with rotten fruit. This rapid post-harvest degradation of the berries' quality results in substantial economic losses, in particular in organic production where development of rot is more likely to appear. The increasing demand for organic products together with novel restrictive regulations on the use of chemical treatments urge the European fruit industry to implement alternative methods to prolong the storage of strawberries after harvest while maintaining fruit quality. We wanted to evaluate the impact of treating stored berries with gaseous ozone on the development of microbiological growth and on key fruit quality parameters. We showed that treating berries with 2 to 3 ppm gaseous ozone slowed down microbiological growth without altering skin color, total soluble solids and acidity. These promising results indicate that ozone can be an alternative method to limit fruit losses after harvest and that further studies must be conducted to confirm these findings.

Keywords: Ozone, strawberries, decay, quality

PP-50

Preservation of fresh strawberries in an ozone-enriched atmosphere

Nikolaos Tzortzakis

Department of Agricultural Sciences, Biotechnology and Food Science, Cyprus University of Technology, 3036, Limassol, Cyprus. Email: nikolaos.tzortzakis@cut.ac.cy

Abstract

Strawberries fruit are highly appreciated by consumers due to their high nutritive value, sweet taste, and fruity flavour. However, strawberries are highly perishable fresh produce, with very short storage period and rapidly are deteriorated mainly by fungal diseases. In the present study, strawberry fruit were purchased at a local market. Examining fruit microflora after 5 days of storage at 12 ^{o}C and 95% relative humidity (RH), in an ozone-enriched atmosphere (0.05-0.2-1.0 ppm), a decrease of colonies of bacteria (at 1.0 ppm of ozone), and of fungi and yeast (at ≥ 0.05 ppm ozone) was observed. In another batch of strawberries, fruits were inoculated with 20 μL of spore suspensions (10^6 spores mL^{-1}) of *Botrytis cinerea* and subjected to either clear air or ozone-enriched air (0.05-0.2-1.0 ppm) at 12 ^{o}C and 95% RH. Fungal lesion growth decreased at the high ozone levels, after the 3rd day of storage. Fungal spore production was decreased up to 32%, 48.3% and 60.9% for 0.05 ppm, 0.2 ppm and 1.0 ppm of ozone concentrations, respectively. *In vitro* studies performed on fungal raised on Potato Dextrose Agar (PDA) for 6-7 days at 12^{o}C and 95% RH revealed no direct effects of ozone on fungal growth (no great effects on colony growth) *per se,* implying that suppression of pathogen development was due in a large part to the impacts of ozone on fruit-pathogen interactions. Indeed, the reproductive phase of the pathogen was greatly affected by the ozone application, with decreased spore production up to 56% in ≤ 0.2 ppm of ozone or complete inhibition at 1.0 ppm of ozone. Therefore, ozone is considered as an alternative sanitizer for the fresh produce preservation.

Keywords: Modified atmosphere storage, ozone-enrichment, spoilage, postharvest fungal pathogens

PP-51

Improvement of fruit quality by continuous ozone exposure during storage

Cyndel Berger[1], Marielle Pagès-Homs[1,2], Léa Volmerange[1], Séverine Maldes[3], Vincent Quintard[4], Frédéric Violleau[1,5]

[1] Plateform TOAsT, University of Toulouse, INP-PURPAN, 31076 Toulouse, France. Email: frederic.violleau@purpan.fr
[2] Plant Physiology, Pathology and Genetics (PPGV), University of Toulouse, INP-PURPAN, 31076 Toulouse, France
[3] Bluewhale, Montauban, France
[4] Boyer, 82200, Moissac, France
[5] Laboratory of Agro-Industrial Chemistry, LCA, University of Toulouse, INRA, 31000 Toulouse, France

Abstract
During storage, microbial contamination of fruits and vegetables can cause serious economic losses. Fruit growers and industrials are therefore looking for solutions capable of effectively reducing pathogenic microorganisms and improving the fruit preservation while leaving little or no residue in the product. Among the emerging strategies, ozone has shown favorable results on extending shelf life of fruits. This study investigated the effect of continuous ozone injections during cold storage period on apples, plums and melons as a non-persistent alternative to chemicals. Fruits were placed in three downscale chambers of 12 m^3 with or without gaseous ozone at two different concentrations. The experiments on apple were conducted on different varieties (Ariane and Rosy Glow). Apples were stored for periods ranging from 1 to 6 months under ozone and ultra-low oxygen atmosphere at 1.5 °C. Plums were also stored in the same atmosphere conditions during 5 weeks at 2 °C. On melon, experiments were conducted under ozone in normal cold-storage conditions at 8 °C during 24 h to 3 weeks. Fruit quality was assessed just after ozone treatment and after a storage at room temperature by physico-chemical and microbiological analysis. On apple, these evaluations were completed with biochemical tests, and sensorial analysis. This study confirmed the results previously obtained by showing a reduction of the number of infected fruits in the ozone chambers, corroborated by the microbiological analysis. A reduction of up to 90% of the fungal flora was observed on melons and apples with the highest ozone dose. Above certain ozone concentrations, phytotoxicity occurred. Furthermore, results of the sensory analysis differentiated ozone and control samples with a tendency of control samples being blander.

Keywords: Gaseous ozone, fruits conservation, Ultra-Low Oxygen atmosphere, storage diseases

PP-52

Essential oil-based formulations for the control of postharvest brown rot

Jovana Hrustic, Brankica Tanovic, Slavica Gasic, Milica Mihajlovic, Marija Stevanovic

Laboratory of Phytopathology, Institute of Pesticides and Environmental Protection, 11080 Belgrade, Serbia. Email: jovana.hrustic@pesting.org.rs

Abstract

Brown rot, caused by *Monilinia* spp., is one of the most important pre- and postharvest diseases of pome and stone fruit worldwide. The disease is controlled by multiple preharvest fungicide applications, since in most European countries including Serbia, postharvest application of fungicides is not allowed. To reduce the amount of synthetic pesticides in the environment and their residues in food products, eco-friendly alternatives to synthetic pesticides became an object of many studies. Our previous investigations showed that essential oils exhibit a great potential to be used as crop protectants against many fungal plant pathogens. The aim of this study was to determine whether essential oils could be effectively used against *Monilinia laxa*, *Monilinia fructigena* and *Monilinia fructicola*, the most important pathogens of the genus *Monilinia* in stone and pome fruit in Serbia. Cultures of *M. laxa*, *M. fructigena* and *M. fructicola* were exposed to a volatile phase of numerous essential oils, including tea tree oil that is already on the market as a biofungicide. The results showed that the volatile phase of a thyme and oregano oils exhibited the highest toxicity. Further experiments *in vitro*, using slightly modified agar overlay technique, showed that developed formulations (emulsifiable concentrates - EC) significantly inhibited mycelial growth of *Monilinia* spp. Experiments *in vivo*, performed on inoculated apple fruits, revealed that formulation process successfully decreased evaporation of the oils from the treated areas and provided significant level of *Monilinia* spp. suppression, 47-61% compared to the control. To our knowledge, EC formulation of the thyme and oregano essential oils for use against *Monilinia* spp. has never been developed before. Presented results are initial findings and, therefore, evaluation of the activity of the developed products should be continued under field conditions to determine efficacy and to estimate economic aspects of its use.

Project 451-03-9/2021-14/200214.

Keywords: *Monilinia*, biological control, oregano, thyme

PP-53

The impacts of rosemary and eucalyptus essential oils and their major component use on the preservation of apple and pear fruits

Panayiota Xylia, Antonios Chrysargyris, Nikolaos Tzortzakis

Department of Agricultural Sciences, Biotechnology and Food Science, Cyprus University of Technology, 3603 Limassol, Cyprus. Email: a.chrysargyris@cut.ac.cy

Abstract

The development of postharvest fungal diseases has resulted in the increase of fruit losses. Natural compounds, including essential oils (EOs), are being investigated as alternatives of synthetic fungicides. The aim of the present study was to assess the effects of eucalyptus (Euc), rosemary (Ros), their 50:50 (v/v) mixture (Euc+Ros) and eucalyptol (Eucalyptol) (the major component of both EOs) on blue rot (*Penicillium expansum*) development, quality attributes and fruit response of apples and pears during shelf life. The results from this study indicated that the *in vitro* growth of *P. expansum* decreased when exposed at eucalyptus EO (Euc-300 μL L^{-1}), rosemary EO (Ros-300 μL L^{-1}) and their mixture (Euc+Ros-100 and 300 μL L^{-1}). Spore production was stimulated with exposure at Ros-100 μL L^{-1}, whilst spore germination decreased with Euc+Ros (100 and 300 μL L^{-1}) and eucalyptol (100 and 300 μL L^{-1}). Regarding the *in vivo* application of the EOs and eucalyptol on inoculated apples and pears showed decreased blue rot's lesion growth in both fruits. Moreover, increased respiration rate was reported on both fruits with the application of Euc+Ros-300 μL L^{-1} and eucalyptus EO (Euc-100 and 300 μL L^{-1}). However, total soluble solids and total acidity did not significantly differ on both fruits. Increased hydrogen peroxide (H_2O_2) levels were observed with the application of Euc+Ros-300 μL L^{-1}in apples, whereas lipid peroxidation levels increased with eucalyptus EO (Euc-100 and 300 μL L^{-1}). Furthermore, increased H_2O_2 levels on pear fruits were reported with Euc-100 μL L^{-1} and Ros-100 μL L^{-1}, whilst exposure to Euc-100 μL L^{-1}, rosemary EO (Ros-100 and 300 μL L^{-1}) and eucalyptol (100 and 300 μL L^{-1}) also increased lipid peroxidation levels. The results from the present study, suggest that the investigated natural products can serve as alternative fungicides for the preservation of fresh apples and pears.

Keywords: Apples, essential oils, pears, *Penicillium expansum*, quality attributes, respiration rates

PP-54

Use of essential oils from *Eucalyptus globulus* and *Pistacia lentiscus* as an additive to the holding solution of *Chrysanthemum indicum* cut flowers

Georgios Toumazou, Panayiota Xylia, Michalis Makrygiorgis, Antonios Chrysargyris

Department of Agricultural Sciences, Biotechnology and Food Science, Cyprus University of Technology, 3036, Limassol, Cyprus. Email: gm.toumazou@edu.cut.ac.cy

Abstract

Chrysanthemum is one of the most commercialized cut flowers, second after cut roses. Today, a main challenge for florists and consumers is to extend the longevity of the cut flowers in vase. The aim of this study was to evaluate the effects of two essential oils (EO) (*Eucalyptus globulous* and *Pistacia lentiscus*) and their mixture, in two concentrations (50 and 150 mg L^{-1}), and their major common compound (α-pinene) in 4% sugar solution, as additives in the holding solution of cut flowers of *Chrysanthemum indicum* "Pina colada". The experiment was carried out in growth chamber and a series of postharvest features was evaluated (vase life, chlorophylls, sugars content, color, stress indices, enzyme activity). The solution was examined for total viable counts and yeasts and filamentous fungi concentrations. Results revealed that even though water uptake was lower at the majority of the treatments with EO, dry matter, an indicator positively correlated with vase life, appeared significantly increased, after the applications with α-pinene (22.9-23.65%) and the mixtures of the EO (23.31-21.48%), compared to water (16.07%) or 4% sugar water (18.07%). Moreover, quality of the flower heads remained unaffected, while leaves started to wilt after day 9, at the high concentrations of EO. The promising results of the study indicate that the higher concentration of *P. lentiscus* and *E. globulous* resulted in a decrease of total viable counts in the solution (1.67 and 1.39 log decrease, respectively) compared to the control (sugar 4%). Moreover, yeasts and filamentous fungi, were found decreased at 150 ppm of *Pistachia* EO (1.36 log decrease) and 150 ppm *Eucalyptus* EO (1.16 log decrease) as opposed to sugar 4%. Based on this finding, alternative means of applications of the tested EO should be evaluated in a way to prolong vase life of chrysanthemum and even to improve postharvest features.

Keywords: Antimicrobial, preservation solution, water uptake, α-pinene

PP-55

Unexplored endemic species of medicinal and aromatic plants as a potential source of natural sanitizers and antioxidants: the case of *Sideritis cypria* Post

Antonios Chrysargyris[1], Ekaterina-Michaela Tomou[2], George Toumazou[1], Panagiota Miltiadous[3], Panayiota Xylia[1], Helen Skaltsa[2], Nikolaos Tzortzakis[1]

[1] Department of Agricultural Sciences, Biotechnology and Food Science, Cyprus University of Technology, 3036 Limassol, Cyprus. Email: gm.toumazou@edu.cut.ac.cy
[2] Department of Pharmacognosy & Chemistry of Natural Products, Faculty of Pharmacy, School of Health Sciences, National & Kapodistrian University of Athens, 15771 Athens, Greece
[3] Department of Nursing, Faculty of Health Sciences, Cyprus University of Technology, 3036, Limassol, Cyprus

Abstract
The search for plant extracts and natural substances with high antimicrobial and antioxidant activity has been of the most intensive fields of research lately. Natural products should not only minimize the risk of diseases caused by microorganisms, but additionally, should minimize food spoilage caused by a series of bacteria and fungi. Towards that direction, underexplored, wild and endemic species come in the front line, as potential candidates to serve this role. An endemic to Cyprus medicinal plant, *Sideritis cypria*, has been recently introduced to conventional cultivation systems, in order to evaluate the biological properties of a range of extracts and essential oils (EO). Firstly, the antioxidant status of the decoction and the infusion of leaves and flowers was evaluated, along with the analysis of their essential oils. Results indicated a lower activity than other species of the *Sideritis* genus. Then, the methanolic extract of the aerial parts of the plant was fractionated using Column Chromatography. The produced fractions were assayed for their antioxidant and antimicrobial activity. Fractions containing compounds with reported antioxidant activity, exhibited remarkable properties. The antimicrobial activity of the fractions was then tested against *Escherichia coli* and *Staphylococcus aureus* subsp. *aureus*, revealing low activity. The next step of the research was to test the activity of the EO and the produced hydrosol, against the selected bacteria. Results revealed the superiority of the EO against the produced hydrosol, and the higher effectiveness of the EO against gram-positive bacteria. While a series of other extracts of *S. cypria* are under evaluation (root extracts) we may conclude that even though a series of parameters (cultivation practices, environmental conditions, extraction methods, etc.) may affect the bioactive status of a plant extract, *S. cypria* is a remarkable candidate as a natural source of bioactive compounds.

Keywords: Endemic species, mountain tea, essential oils, antimicrobial activity

PP-56

In vitro effect of eucalyptus and rosemary essential oils and eucalyptol against *Fusarium oxysporum* and *Botrytis cinerea*

Efraimia Hajisolomou, Panayiota Xylia, Antonios Chrysargyris, Nikolaos Tzortzakis

Department of Agricultural Sciences, Biotechnology and Food Science, Cyprus University of Technology, 3036, Limassol, Cyprus. Email: efraimiahadjisolomou@gmail.com

Abstract

One of the biggest problems of fruits and vegetables losses is postharvest fungal infestations. In an effort to reduce the use of chemicals, alternatives such as essential oils (EOs) and other natural compounds are attracting research interest. The present study aims to examine the antifungal properties of the essential oils of eucalyptus (Euc), rosemary (Ros) their combination (Euc+Ros) and eucalyptol (the major component) against *Botrytis cinerea* and *Fusarium oxysporum in vitro*. The results showed that regarding the growth of the fungus *F. oxysporum*, all applied treatments resulted in decreased lesion growth compared to the control (smaller growth at 300 μL L^{-1}). *F. oxysporum* spore germination was decreased with the Euc+Ros 300 μL L^{-1} application compared to the control. The spore production of *F. oxysporum* with Ros or Euc+Ros resulted in no differences to the control, but treatment with Euc-300 μL L^{-1} and Eycalyptol-300 μL L^{-1} showed lower values compared to the control. The results for *B. cinerea* showed that Euc+Ros 300 μL L^{-1} and Ros 300 μL L^{-1} treatments had differences in fungal growth from the control. Ecualyptol-300 μL L^{-1} showed greater decrease in *B. cinerea* growth (28.18 cm^2) compared to the control (48.00 cm^2), followed by Eucalyptol-100 μL L^{-1} (39.76 cm^2). Spore germination of *B. cinerea* was found lower at Ros, Euc+Ros and eucalyptol (100 and 300 μL L^{-1}), while Euc-300 μL L^{-1} also showed lower spore germination compared to the control. *B. cinerea* spore production was remained similar among treatments, except of Euc+ Ros-100 μL L^{-1} which led to lower spore production as to the control. Due to the encouraging *in vitro* results, *in vino* research is needed on fresh produce to support these findings.

Keywords: Eucalyptus, rosemary, essential oils, eucalyptol, spore production, spore germination, antifungal activity

PP57

In vitro antifungal activity of commercial essential oils in vapor phase against *Monilinia fructicola* and *Botrytis cinerea*

Samuel Alvarez-García[1], Marwa Moumni[2], Gianfranco Romanazzi[2]

[1] Engineering and Agricultural Sciences Dep., University of León, 24071, León, Spain. Email: salvg@unileon.es
[2] Department of Agricultural Food and Environmental Sciences, Marche Polytechnic University, 60131 Ancona, Italy

Abstract
Gray mold and brown rot, caused respectively by *Botrytis cinerea* and *Monilinia fructicola*, are fungal diseases responsible for significant losses during the storage of fruit and vegetables. Nowadays, the focus in the control of postharvest diseases is shifting towards more sustainable strategies, including the use of plant secondary metabolites. In this study, the antifungal effect of essential oils (EOs) of *Melaleuca alternifolia, Origanum vulgare, Thymus vulgaris, Thymus serpyllum, Citrus bergamia, Rosmarinus officinalis, Lavandula officinalis, and Lavandula hybrida* was tested *in vitro* against a *M. fructicola* strain isolated from nectarines and *B. cinerea* B05.10. To perform the experiments, non-vented VOC Chambers were used, growing the fungal strains in the upper plate and placing a filter paper soaked with the corresponding volume of each EO in the lower one. Three concentrations were tested (34.25, 68.5, and 137 µL L^{-1}). Radial growth was measured and the Minimum Inhibitory Concentration (MIC) was calculated. *B. cinerea* showed MICs of < 34.25 µL L^{-1} for *O. vulgare, and* 68.5-137 µL L^{-1} for *T. vulgaris*, and *T. serpyllum*. *M. fructicola* MICs were < 34.25 µL L^{-1} for *O. vulgare*, *T. vulgaris*, and *T. serpyllum;* and 68.5-137 µL L^{-1} for *C. bergamia, R. officinalis, L. officinalis, and L. hybrid*. Moreover, *O. vulgare* EO presented fungicidal activity on *B. cinerea* at 137 µL L^{-1} and at 68.5 µL L^{-1} against *M. fructicola*. Overall, *M. fructicola* resulted more sensitive to tested EOs than on *B. cinerea*. Further *in vivo* studies need to be conducted to evaluate the application of tested EOs for the control of gray mold and brown rot.
This work was conducted within the framework of the PRIMA StopMedWaste project, which is funded by PRIMA, a program supported by the European Union.

Keywords: *Botrytis cinerea*, essential oils, fumigation, *Monilinia fructicola*, postharvest, VOC chamber, volatile

PP-58

Preliminary research regarding thermal treatments applied to the bean seeds

Eliza Teodorescu

Laboratory of Plant Protection and Floriculture, Vegetable Research and Development Station Buzău, 120024, Buzău, Romania. Email: teodorescu.eliza@gmail.com

Abstract

The losses caused by the bean weevil (*Acanthoscelides obtectus)* to the bean (*Phaseolus vulgaris L.*) seeds can be total. Nowadays, the chemical treatments used are very toxic and it may endanger human life. An alternative to this practice is represented by the thermal treatments applied to the bean seeds after harvest. In 2020, at Vegetable Research and Development Station Buzau (V.R.D.S. Buzau), Romania, there were cultivated many bean accessions (germplasm collection). Seeds harvest was made in stages during many weeks, each accession being harvested separately. The seeds of each accession were exposed to a dry thermal treatment of 60 ^{o}C temperature for 3 days and they were stored in the fridge at 2 ^{o}C. The 60 ^{o}C temperature was selected because the sprouting percent of those seeds was higher from the seeds preserved at 70 ^{o}C and the rising period was smaller.

Keywords: *Acanthoscelides obtectus*, bean seeds, *Phaseolus vulgaris* L., dry thermal treatment

PP-59

Postharvest fungal pathogens of peach fruit in Serbia

Jovana Hrustic, Milica Mihajlovic, Brankica Tanovic

Laboratory of Phytopathology, Institute of Pesticides and Environmental Protection, 11080 Belgrade, Serbia. Email: jovana.hrustic@pesting.org.rs

Abstract

Peach (*Prunus persica* L. Batsch) is an important fruit crop which place Serbia among top five peach-producing countries in Europe. The production is seriously threatened by numerous plant pathogens that develop in the field during the growing season, as well as after harvest, during storage, shipping and marketing. Postharvest diseases caused by pathogenic fungi could pose significant concerns to producers because of economic losses they can cause, as well as to consumers because of toxic metabolites that they may produce. The aim of the present investigation was to assess the incidence of postharvest fruit rot, as well to isolate and identify the main postharvest pathogens of peach fruit. During summer in 2021, mature symptomless peach fruits (cvs. 'Red Haven' and 'Royal Glory') were collected from two representative orchards in the main peach-growing area in Serbia. The fruit samples were individually packed in bags and incubated at room temperature for 10 days. Fruit rot development was observed daily, followed by the isolation of the causal agent from the diseased tissue. Derived isolates were identified based on pathogenic, morphological and molecular features. High level of postharvest fruit rot incidence was recorded, 44.3% of the fruits from the first and 70% from the second orchard. Numerous fungal species, belonging to more than 10 genera (*Rhizopus, Aspergillus, Monilinia, Alternaria, Penicillium, Trichothecium, Fusarium, Botryospheria, Mucor,* and *Epiccocum*) were identified. The most harmful pathogens were *Rhizopus* species that caused severe fruit rot after the incubation of three days. The second group of the most frequently found pathogens was *Monilinia* spp.. *Monilinia fructicola*, the most destructive well-known peach pathogen was detected in both tested orchards. Further studies will reveal if detected pathogens were the causal agents of latent infections that developed into rot after harvest, or they were present on the fruit surface.

Keywords: Peach, *Rhizopus*, *Monilinia*, postharvest losses

PP-60

The possibilities for Hungarian sour cherries for storage and elongation of fresh consumption

Kata Mihály[1], Erzsébet Szöllösi[2], Judit Rita Homoki[2], Antal Nagy[3], Ferenc Takács[4], Ezsébet Sándor[1]

[1] Faculty of Agricultural and Food Sciences and Environmental Management, Institute of Food Science, University of Debrecen, 4032, Debrecen, Hungary. Email: takacsf72@gmail.com
[2] Faculty of Agricultural and Food Sciences and Environmental Management, Institute of Food Technology, University of Debrecen, 4032, Debrecen, Hungary
[3] Faculty of Agricultural and Food Sciences and Environmental Management, Institute of Plant Protection, University of Debrecen,4032, Debrecen, Hungary
[4] Institutes for Agricultural Research and Educational Farm, University of Debrecen, 4244, Újfehértó, Hungary

Abstract
Hungarian sour cherry varieties are not only famous for their nutritional values with extremely high levels of anthocyanins and phenolic compounds, but also for their possibility to use either for canning industry or for fresh consumption. Short shelf life of the non-climacteric sour cherry fruits is the primary difficulty for increasing the market of this fresh fruit. The aim of our research was to compare the conventional and the modified atmosphere packaging (MAP) storage of three Hungarian sour cherry varieties ('Érdi bőtermő', 'Újfehértói fürtös' and 'Petri') from the same orchard. Harvested fruits were stored for 6 weeks at 0 °C, either in normal or MAP storage, using StePac Xtend (cherry) packaging. Shelf-life was monitored, and disease incidence was calculated during one week following storage. The fruit firmness of the samples was obtained in Durofel index. The surface mold number was determined in the case of different storage methods. The total anthocyanin concentrations characteristic of these sour cherry cultivars were determined by pH-differential method. There was a significant difference between varieties following the cold storage. The number of molds isolated from the surface of sour cherries was lower in the case of MAP storage than one stored in normal atmosphere. The MAP significantly reduced the rate of weight loss and effectively preserved the quality of the samples compared to normal atmosphere storage. The fruit firmness of the 'Érdi bőtermő' and 'Petri' cultivars increased following MAP storage. Moreover, MAP effectively preserved the total anthocyanin content of the samples in some cases too.
The work/publication is supported by the EFOP-3.6.1-16-2016-00022 project. The project is co-financed by the European Union and the European Social Fund.

Keywords: Sour cherry, storage, MAP, shelf life, total anthocyanin content

PP-61

Effect of maturity in carrot (*Daucus carota* ssp. sativus) on storage diseases after long time storage

Pia Heltoft, Mette Goul Thomsen

NIBIO, Norwegian Institute of Bioeconom, Nylinna 226, 2849 Kapp, Norway. Email: mette.thomsen@nibio.no

Abstract

The maturity stage of carrot and the temperature strategy during storage are essential factors in maintaining quality during long-term storage. The aim of the study was to examine the effect of maturity and storage strategy on storage quality of carrot (*Daucus carota* ssp. sativus). Two cultivars, Nominator and Romance, harvested at three different maturity levels were stored with different temperature strategies in small-scale experimental stores. The different maturity levels were obtained by different sowing dates. The study was conducted over 2 years and storage seasons in 2019-2020 and 2020-2021. The carrots were stored with three different temperature strategies with stabile temperature at 0 ºC, 2 ºC or 0 ºC interrupted with intervals of 2 weeks with 4 ºC in February and in March. After seven-month storage we found that weight loss was higher (7.8%) after storage when the temperature was fluctuated (up to 4 ºC in February and March) during storage than at stabile temperatures at 0 ºC or 2 ºC. The number of healthy roots after storage was highest in the most mature carrots (91%) while there were less healthy roots in the least mature roots (85%). Diseases detected after storage were grey mould (*Botrytis cinerea*), liquorice rot (*Mycocentrospora acerina*), tip rot, crater rot (*Fibularhizoctonia carotae*), Fusarium rot (*Fusarium* ssp.) and cavity spot (*Pythium* spp.). There were significantly more liqourice rot in Nominator (1.9%) than in Romance (0.6%). There was more tip rot in the least mature carrots (3.3%) compared to the other two maturity levels (1.3 and 1.5%). While percentage of roots with fusarium were highest in the roots at higher storage temperatures, 2 ºC (1.1%) and at unstable storage with temperature fluctuations up to 4 ºC twice during the storage season (0.6%) than at stable storage temperatures at 0 ºC (0.06%).

Keywords: Root vegetable, temperature, maturity, sowing time

PP-62

Oregano, ironwort and sage herbs extracts towards common foodborne pathogens

Panayiota Xylia[1], Antonios Chrysargyris[1], Panagiota Miltiadous[2], Nikolaos Tzortzakis[1]

[1] Department of Agricultural Sciences, Biotechnology and Food Science, Cyprus University of Technology, 3036, Limassol, Cyprus
[2] Department of Nursing, Faculty of Health Sciences, Cyprus University of Technology, 3036, Limassol, Cyprus. Email: panagiota.miltiadous@cut.ac.cy

Listeria monocytogenes represents one of the most dangerous food-borne pathogens with higher death rates than other food-borne diseases and has been associated with food consumption, including raw vegetables. *Salmonella enterica* subsp. *enterica* has been previously isolated from commercially produced foodstuffs such as foods containing raw eggs. The aim of the present study was to assess the effects of the essential oil (EO) and hydrosol extracts of the aromatic herbs *Origanum dubium*, *Sideritis cypria* and *Salvia fruticosa* on the *in vitro* growth of the commercially provided *Salmonella enterica* subsp. *enterica* (ATCC 51741) (isolated from pasta) and *Listeria monocytogenes* (ATCC 19111) (isolated from poultry). The extracts were prepared in various concentrations and were incubated with the bacteria in a nutrient medium base for 24 hours. Kinetic readings were obtained every 30 minutes and minimum inhibitory concentration (MIC) and lethal dose 90 (LD_{90}) were determined. *O. dubium* EO exhibited a significant inhibitory effect on *S. enterica* (MIC 1.56 mg mL^{-1} and LD_{90} 12.5 mg mL^{-1}) and *S. fruticosa* EO exhibited a significant inhibitory effect on *L. monocytogenes* (MIC 1.56 mg mL^{-1} and LD_{90} 100 mg mL^{-1}). *O.dubium* hydrosol exhibited a stronger inhibitory effect on both bacteria compared to the other two hydrosols. Disc diffusion assay exhibited a highlighted susceptibility of both microorganisms tested to *O.dubium* EO, at 24 hrs incubation time, with an inhibition zone of 30 mm and 40 mm for *S. enterica* and *L. monocytogenes*, respectively. The results from the present study, suggest that the investigated aromatic herbs can serve as an inhibiting factor on the development of the studied pathogens, for the maintenance of shelf life of foodstuffs that could be at risk of being infected. However further investigation is required *in vivo* in order to validate these *in vitro* effects.

Keywords: Essential oils, pathogens, antimicrobial, food-borne, hydrosols

PP-63

The use of *Origanum dubium* as sanitizing agent against *Salmonella enterica* and *Listeria monocytogenes* on tomato and cucumber

Panayiota Xylia[1], Antonios Chrysargyris[1], Panagiota Miltiadous[2], Nikolaos Tzortzakis[1]

[1] Department of Agricultural Sciences, Biotechnology and Food Science, Cyprus University of Technology, 3036, Limassol, Cyprus. Email: pa.xylia@edu.cut.ac.cy
[2] Department of Nursing, Faculty of Health Sciences, Cyprus University of Technology, 3036, Limassol, Cyprus

Abstract

Outbreaks of foodborne illnesses due to the consumption of fresh produce have been linked with the presence of *Salmonella enterica* and *Listeria monocytogenes*, among other pathogens. Natural products such as essential oils (EOs) and plant extracts are being widely investigated as alternative, eco-friendly sanitizing agents in the food industry. The present study aimed to assess the effectiveness of Cypriot oregano (*Origanum dubium*) EO and hydrosol at two different doses (combination of time and concentration selected after preliminary screening) (EO dose A: 0.01% for 10 min; EO dose B: 0.1% for 10 min; hydrosol dose A: 0.1% for 20 min; hydrosol dose B: 0.5% for 20 min) against *S. enterica* and *L. monocytogenes* inoculated on tomato and cucumber fruits stored at 11 ^{o}C. The dipping application method was used and fruits were stored for one week. The results showed that on the first day of storage of tomato fruits, EO (both doses) showed the greatest activity against *S. enterica* (up to 2.40 log decrease) compared to the control, whilst no difference was observed between the two doses. The application of EO dose A on tomato fruit revealed a 1.42 log decrease of the *L. monocytogenes* population compared to the control after seven days of storage, while all other treatments they did not differ. Regarding cucumber fruits, higher antibacterial activity against *S. enterica* was found with the application of EO dose A as to EO dose B (6.43 and 6.92 log cfu/fruit, respectively) after seven days of storage. In addition, the application of oregano EO (both doses) and hydrosol dose A presented greater reduction (up to 1.91 log reduction) of *L. monocytogenes* on cucumbers after one day of application. These findings suggest the use of oregano on postharvest treatments on fresh produce as an alternative sanitizing mean on different produce and against different foodborne pathogens.

Keywords: *Origanum dubium*, *Salmonella enterica*, *Listeria monocytogenes*, tomato, cucumber

PP-64

Development of a smart tomato for physiological sensing and fruit quality assessments along the supply chain

Malick Bill[1], Lungelo Ntamane[1], Andre Broekman[2], Wynand JvdM Steyn[2], Lise Korsten[1]

[1] Department of Plant and Soil Sciences, University of Pretoria, Pretoria, Gauteng, South Africa. Email: Lise.Korsten@up.ac.za
[2] Department of Civil Engineering, University of Pretoria, Pretoria, Gauteng, South Africa

Abstract
As a climacteric fruit, tomatoes are prone to rapid quality losses at the postharvest stage. The effect can be further compounded by improper handling contributing to decay and losses at different points along the supply chain. A reduction of such losses is crucial to increase food availability hence, the current study aimed at developing a tomato-mimicking data logger device (smaTo) to monitor the tomato supply chain in order to reduce postharvest losses and guarantee a consistent quality product. The smaTo was developed, optimized, and confirmed to be working properly. The pack line operation data indicated that the fruit experienced high intensity, short duration impact forces spread uniformly over the surface of the fruit while low intensity, long duration impact forces spread over a concentrated area of the fruit were experienced during distribution (short and long distance) by road. The trade-off between high intensity, short duration, uniformly distributed acceleration forces and low intensity, long duration, concentrated acceleration forces need to be further investigated. Significant amounts (> 10%) of fruit were decayed (*Alternaria* and *Rhizopus* rots), deformed, and bruised at the market-end stage. A positive correlation was observed between average cumulative kinetic energy (CKE) and decayed tomatoes (0.49) as well as the CKE standard deviation and shrivelled tomatoes (0.76). Very strong correlations were also observed between bruised, shrivelled, and deformed tomatoes. The reliability of the smaTo proved its use in research and experimentation to readily obtain information that would otherwise be costly and time consuming when using existing instrumentation techniques.

Keywords: Postharvest losses reduction, artificial intelligence, microchip technology

Author Index

A

Abdelfattah, Ahmed……62
Abdullah, Roheena……..114
Acciarri, Paolo.....106
Agosteo, Giovanni E……62
Ahmed, Zienab F.R……71,114
Akselsen, Inger-Lise……93
Alblooshi, Suhaila M.M……71
Alkaabi, Bashaer M.T……71
Alkan, Noam……55,60,61,119
Allagui, Mohamed Bechir……81,132
Alvarez, María V……78
Alvarez-García, Samuel……142
Amaral Carneiro, Greice……90,115
Ambrico, Marianna……125
Ambrico, Paolo Francesco……125
Ançay, André……134
Angeli, Dario……110,118
Anguezomo Assoumou, Whitney Rakelle..94
Aragon, Liliana……121
Arens, Paul……63
Argenta, Luiz Carlos……87
Argente-Sanchis, Maricruz……...78,133
Asalf, Belachew……48,83,93
Azebaze, Alphonse……67

B

Bai, Yuling……63
Ballester, Ana-Rosa……50,91,105
Balsells-Llauradó, Marta……107
Bancal, Victoria……70
Baraldi, Elena.....51,124
Barger, Nataly……62
Baric, Sanja……90,115
Baronciani, Luciano.....106
Belgacem, Imen……62
Ben Amara, Hajer……81,132
Berger, Cyndel……70,136
Bertolini, Paolo.....51
Bill, Malick……56,100,149
Birlia, Christina……74
Botsaris, George……84
Bottalico, Antonella.....122
Boutry Clémence.....130
Bovy, Arnaud……63
Brat, Pierre……70
Brazaityte, Ausra……108,123
Broekman, Andre……149
Büchele, Felix……127,128,129
Buglia, Luca……64
Bühlmann, Andreas……90
Bustamante, Marcelo……112

C

Campobasso, Davide.....131
Caputo, Marika.....77,122,131
Casals, Carla……40,107
Ceredi, Gianni.....106,124
Chaves Lopez, Clemencia.....96
Chidamba, Lizyben……56,100
Chrapaciene, Simona……108,123
Christen, Danilo……134
Chrysargyris, Antonios….75,84,117,126,138
139,140,141,147,148
Coetzee, Charlene……44

D

D'Ambrosio, Pasquale.....77,131
Da Silva, Janaiana Catarina……127
De Chabot-Tramecourt, Geoffroy……59
De Coninck, Barbara……102,103
De Lapeyre de Bellaire, Luc……70
De Miccolis Angelini, Rita Milvia.....49,125
Dene, Lina……108,123
Dervis, Sibel……54,86
Di Francesco, Alessandra……51,66, 124
Diaz, Andres V. Casas……121
Difonzo, Graziana.....131
Dipierro, Nunzio.....122
Djoukeng, Henri Grisseur……67,94
Do Amarante, Cassandro Vidal Talamini.127
D'Ortenzio, Annamaria L.....80,97,106
Droby, Samir……38,95,101,105
Duanis-Assaf, Danielle……61,119
Duvenage, Stacey……44

E

Ebner, Ines……57
Ermacora, Paolo……66
Everett, Kerry……47

F

Faretra, Francesco.....49,125
Faust, James……68
Fava, Giacomo.....106
Feldman, Mark……119
Fernández, Ysadora……72,112
Fernández-Catalán, Asunción……78,133
Feygenberg, Oleg……55,60,61,95,101,119
Fisher, Brent……47
Flury, Pascale……130

G

Gabriels, Suzan……..……..63
Galsurker, Ortal……..……61
Garello, Marco……79,109
Gasic, Slavica……..137
Gerbaud, Sylvain……..…70
Gerin, Donato……..125
Giannakas, Aris……..……..74,75
Gokul, Jarishma Keriuscia…….……100
González, Andrea……..……72
González-Candelas, Luis……50,91,105
Gottsberger, Richard A……..89
Grabulos, Joel……..……...70
Grimal, Amparo……133
Guarnaccia, Vladimiro…….……92
Gularte, Paulo Sérgio……127
Gunamalai, Lavanya……73

H

Hajisolomou, Efraimia……..……..75,141
Halvorsrud, Mirjam……..……..48
Hannachi, Ibtissem……..……81,132
Hasna, Luna……..……47
Heltoft, Pia……..83,146
Henríquez, José Luis……..……..72,112
Hertog, Maarten……..…102,103
Homoki, Judit Rita……..……..145
Hrustic, Jovana……137,144
Hubert, Olivier……..……..70

I

Indergaard, Erlend……83
Ippolito, Antonio.....41,77,113,122,131

J

Jabeen, Farwa……..……..66
Jijakli, Haissam……..……39

K

Kamou, Natalie……..……53
Karaoglanidis, George……..…52,53,88
Koller, Martin.....130
Kollia, Eleni……..……..74
Kopsacheili, Anna……..……74
Korsten, Lise……..44,56,100,149
Krasnow, Charles……..……120
Kumar, Ajay……...95,101
Kyriakou, Katerina……75

L

Landi, Lucia.....49,80,96,97
Lauzike, Kristina……..……108,123
Le, Vinh Hong……93
Leichtfried, Thomas……..……89
Levin, Elena……..……105
Li Destri Nicosia, Maria G……62
Librizzi, Valentina T……..62
Lindou Peyoumeya, Nestor……94
Lisco, Anna.....122
Llobregat, Belén……..……50,91
Luzzatto-Knaan, Tal……..62

M

Makau, Sarah Mojela……..…80,97
Makrygiorgis, Michalis……139
Maldes, Séverine……..136
Mancini, Valeria……80,97
Martínez-Blay, Victoria……..…78
Martini, Marta……..……..66
Massart, Sébastien……..……..39
Maurer, Dalia……..…55,60,61,119
Mazzoni, Stefano.....106
Mechoulam, Raphael……..…119
Menkissoglou, Urania……..……..53
Mihajlovic, Milica……..……137,144
Mihály, Kata……..145
Miliauskiene, Jurga……..108,123
Millar, Paul……..……68
Miltiadous, Panagiota……..140,147,148
Mincuzzi, Annamaria.....77,122,131
Montesinos, Clara……..82
Mosca, Saveria.....113
Moumni, Marwa……..43,80,81,132,142
Munoz, Melissa……..……68
Murciano, Celia……..……46
Murolo, Sergio……..……..97

N

Nagy, Antal……..……145
Neri, Fiorella.....51
Neuwald, Daniel Alexandre..87,127,128,129
Nicolaï, Bart……..102,103
Nordskog, Berit……48,93
Normand, Alain……..70
Nouaillac, Lucie……..……70
Ntamane, Lungelo……..……149
Ntasiou, Panagiota……..……..52
Nuñez, Emilia……..121

O

Ogoshi, Claudio……..……..87
Orihuel-Iranzo, Benito……..…46
Öttl, Sabine……..……..57
Ozden, Mustafa……..……..54,86

P

Pagès-Homs, Marielle……..70,136
Palara, Ugo.....51
Palou, Lluís……..……69,77,78,133
Pangallo, Sonia……..……62
Pansera-Espíndola, Bruno……129
Papadakis, Emmanouil……..……..53
Papastavropoulou, Konstadina……116
Parra, Javier……..……..46
Pasvanka, Konstantina……..…116
Patel, Manish Kumar……..……60
Peralta Ruiz, Yeimmy Yolima.....96
Pérez-Gago, Maria B……78,133
Perminow, Juliana……..……..93
Persen, Ulrike……..……..89
Piancatelli, Simone……80
Pilla, Ricardo Bauer……..…129
Pizzinat, Alan……..……92
Placi, Nicola……..…124
Pollastro, Stefania.....49,125
Proestos, Charalampos……..74,75,116
Prusky, Dov……..……99
Pugeaux, Aurélien……..……..70
Pushparajah, Shamini……..……47

Q

Quintard, Vincent……..……..136

R

Ragni, Marco.....77
Raguseo, Celeste.....49
Rajestary, Razieh……..…117
Raphael, Ginat……..……73
Rasiukeviciute, Neringa……108,123
Rebeaud, Séverine Gabioud……..…57,134
Reiterer, Juliane……..……89
Reverberi, Massimo.....98
Reyes-Dominguez, Yazmid……57
Roman, Tomas……..……..110,118
Romanazzi, Gianfranco.....43,49,80,81,96
97,106,117,132,142
Rosati, Marco……..……109
Rotolo, Caterina……..……..125
Rotondo, Palma Rosa……..……125
Rubák, Petr……..……65

S

Sadallah, Abderraouf……..……66
Salim, Shoshana……95,101
Salmas, Constantinos……..……74,75
Samaras, Anastasios……52
Samuoliene, Giedre……108,123
Sándor, Ezsébet……..……145
Sanzani, Simona Marianna.....77,98,113
Saquet, Adriano Arriel……129
Sare, Abdoul Razak……..39
Schaffer, Arthu……..……99
Schärer, Hans-Jakob.....130
Schena, Leonardo……..……..62
Schiavon, Giada……..……..79,109
Schmidt, Denise……..……129
Schnabel, Guido……68
Schotsmans, Wendy……..…59
Schwitter, Patricia.....130
Scialanga, Beatrice……124
Sela, Noa……..……99
Sgaramella, Michele.....113
Shahwar, Durray……71,114
Sharma, Vijay Kumar……95,101
Silva-Alejandre, Víctor……..……..105
Sionov, Edward……..……95
Skaltsa, Helen……..140
Solfrizzo, Michele.....113
Solsona, Cristina……..……40
Spadaro, Davide……..37,79,92,109
Stefanou, Constantinos……..…126
Steffens, Cristiano André……..127
Steinberg, Doron……..…119
Stevanovic, Marija……..137
Steyn, Wynand JvdM……..……149
Storti, Alberto.....115
Sudheeran, Pradeep Kumar……..……55
Summo, Carmine.....131
Surico, Rosalinda.....131
Sutuliene, Ruta……108,123
Szöllösi, Erzsébet……..……..145

T

Taberner, Verónica……..69,78,133
Takács, Ferenc……145
Tanovic, Brankica……137,144
Tedjon, Yannick Frank Tanku……..……67
Teixidó, Neus……40,76,107,111
Teodorescu, Eliza……143
Testempasis, Stefanos……53,88
Thewes, Fabio Rodrigo.....128
Thomsen, Mette Goul……..……83,146
Tomada, Selena……..……90,115

Tomou, Ekaterina-Michaela……140
Torres, Rosario……..40,58,76,107,111
Toumazou, Georgios……139,140
Tsintila, Vasiliki……88
Tulukoglu Kunt, Keziban Sinem……...54,86
Turrini, Lorenzo……110,118
Tzimikas, Stergios……..116
Tzortzakis, Nikolaos…….75,84,104,117,126
135,138,140,141,147,148

U

Usall, Josep……40,76,107,111

V

Valero-Jiménez, Claudio A……58
Valiuskaite, Alma……108,123
Vall-llaura, Núria……..76,107,111
van Kan, Jan A.L……58
Varone, Véronique……134
Vastakaite-Kairiene, Viktorija…….108,123
Verde Yáñez, Lucía……..76,111
Vergara, Michelle……..47
Vieira, Marcelo José……..87
Vieweger, Anja.....130
Vilanova Torren, Laura……..58
Viljoen, Francois……56
Violleau, Frédéric……70,136
Virsile, Akvile……108,123
Visser, Richard.....63
Vleeshouwers, Vivianne……63
Volmerange, Léa……...70,136
Voorbraak, Pauline……..…….36

W

Waqas, Muhammad……..92
Watkins, Chris……42
Woltering, Ernst……..……..63
Wood, Peter……..47
Wood, Rachael Maree……..87,127,129

X

Xylia, Panayiota……75,84,117,126,138
139,140,141,147,148

Z

Zajkowska, Edyta……..……65
Zanella, Angelo……..……57
Zanella, Samara Martins……127
Zeni, Fabio……..……..110,118
Zhao, Yijie……..……..102,103
Zhimo, V. Yeka……..……95,101
Ziv, Carmit……73,99,120

Sponsors

DIAMOND SPONSOR

JANSSEN PMP
PRESERVATION AND MATERIAL PROTECTION
a division of Janssen Pharmaceutica NV

JANSSEN PMP® a division of Janssen Pharmaceutica NV is a long-established world leader in the development of innovative solutions, which extend shelf-life and preserve the quality of fresh produce. JANSSEN PMP® provides post-harvest solutions for the fresh produce industry across the globe. JANSSEN PMP® is headquartered in Belgium.

Visit our Website: www.janssenpmp.com for more information about our products and services.

PLATINUM SPONSOR

CITROSOL develops increasingly sustainable products and systems with the aim of prolonging the freshness and shelf life of fresh fruit and vegetables with the maximum guarantee of food safety. In this way, we minimise post-harvest losses along the distribution chain and, consequently, avoid food waste. All our developments are increasingly sustainable, seeking economic growth and social and environmental balance. We reduce our climate footprint, carbon footprint, water and energy consumption and avoid waste management. We are currently headquartered in South Africa and have in-house staff in Egypt and Peru. We are a leader in Mediterranean countries such as Turkey and Egypt, and have a significant presence in the Asia-Pacific region. We have been present in Australia for decades and in more than 22 countries around the world.
Visit our Website:www.citrosol.com for more information about our products and services.

GOLDEN SPONSOR

Biopreparáty spol. s r.o. is a Czech company founded in 1997. We are an R&D oriented SME that is fully committed to development and introduction of original biological products in agriculture and amenity markets. We serve markets mainly in Europe, North Africa, Middle East, and China and we plan to expand our business more on the African continent, in the Americas and Asia-Pacific soon.
Visit our Website: www.biopreparaty.eu for more information about our products and services.

SILVER SPONSOR

BRONZE SPONSORS

SUPPORTERS