Cost Action UV4growth

mini-conference

Cork, Ireland, 23/24 November 2011

MetabolUV

Interactive effects of UV-B radiation with abiotic and biotic factors

Programme and abstracts

Coláiste na hOllscoile Corcaigh, Éire
University College Cork, Ireland

ENVIRONMENTAL RESEARCH INSTITUTE
UNIVERSITY COLLEGE CORK

Welcome to the UV4growth mini-conference

MetabolUV

Interactive effects of UV-B radiation with abiotic and biotic factors

Dear colleagues,

as organizing committee we have the pleasure of welcoming you to the Environmental Research Institute of University College Cork, Cork, Ireland, to attend the UV4growth mini-conference MetabolUV - Interactive effects of UV-B radiation with abiotic and biotic factors.

UV4Growth is a COST-funded network of researchers with interests in the effects of UV-B radiation on plants (http://www.ucc.ie/en/uv4growth/). Within the UV4Growth network, workgroup 2 explores the interface between plant, food and environment, and specifically studies regulation of plant metabolites by UV-B radiation. The MetabolUV mini-conference therefore has a strong focus on UV-B induced plant metabolites, and their importance for human nutrition.

The mini-conference aims to explore challenges and opportunities for ongoing UV-B research by addressing questions such as;

- Which kind of food is demanded by the consumer in future? What are the consequences for our UV-B research?
- What are the relevant questions that our future research needs to address, e.g. new research topics, new collaborations and new research approaches?
- What are the consequences of our UV-B research for the future horticultural practice, e.g. new technologies, new applications, new crop management strategies?
- How will the global climate develop? Which are the consequences for our UV-B research? Which recommendations are demanded by various stakeholders, e.g. industries, politicians, and consultants?

It is our hope that during these days everybody will have an excellent possibility to meet colleagues, to develop new friendships and to establish fruitful collaborations. The financial support of COST for organising this mini-conference is gratefully acknowledged.

We wish you all a very successful conference and a pleasant stay in Cork.

Marcel Jansen

Nora O'Brien

Monika Schreiner

Conference Programme UV4growth
November 2011

Wednesday 23 November	Time	Title
REGISTRATION & LUNCH	12.00 – 1.45	
WELCOME	1.45 – 2.00	Dr. Marcel Jansen – Chair UV4growth Prof. John O'Halloran – Head School of BEES Prof. Monika Schreiner – Leader WG2
Chairperson	**Prof. Nora O'Brien**	
1	Dr. Juan Valverde 2.00 – 2.40	Irish Phytochemical Food Network: a farm to fork approach to study phytochemicals
2	Dr. Tom O'Connor 2.40 – 3.20	Major changes in food consumption trends, the relationship between these and the rise in nutrition related non-communicable diseases (NR-NCD) and the current Dietary Guidelines regarding nutrition and health
3	Dr. Marcel Jansen 3.20 – 3.40	Dynamic changes in plant secondary metabolites during UV-B acclimation in *Arabidopsis thaliana*
4	Dr. Katharina Schoedl 3.40 – 4.00	Profiling of target polyphenols in non-treated and UV-B treated grapevine (*Vitis vinifera* L.) leaves
Coffee BREAK	4.00 – 4.30	
Chairperson	**Prof. Eva Rosenqvist**	
5	Prof. Richard Mithen 4.30 – 5.10	Broccoli, glucosinolates and health
6	Ms. Claudia Scattino 5.10 – 5.30	Polyphenolic profiling in two cultivars of peaches treated in post-harvest with UV-B radiations
7	Mr. Johann Martínez-Lüscher 5.30 – 5.50	Influence of UV-B on phenolic compound biosynthesis in grape berry skin
8	Prof. Éva Hideg 5.50 – 6.10	Sweet and helpful stuff: carbohydrate-containing biomolecules as potential antioxidants
DINNER	7.30	Jacobs on the Mall

Thursday 24 November		
Coffee	8.30 – 9.00	
Chairperson	**Prof. Barbro Winkler**	
1	Prof. Matthijs Dekker 9.00 – 9.40	Bioactive components in plant foods; results and opinion of the EU-COST926 action
2	Ms. Petra Majer 9.40 – 10.00	Living under the sun: singlet oxygen neutralizing by flavonoids in sun and shade linden leaves
3	Dr. Inga Mewis 10.00 – 10.20	Similarities in host-plant defense induced by UV-B and fungal pathogens
4	Dr. Susanne Huyskens-Keil 10.20 - 10.40	Interactive effects of drought stress and UV-B radiation on plant responses and secondary metabolites in lettuce (*Lactuca sativa* L.)
5	Prof. Eva Rosenqvist 10.40 – 11.00	Plant research with end users in the horticultural production industry – what can we do with UV-B?
6	Ms. Susanne Neugart 11.00 – 11.20	Temperature influences the efficiency of moderate UV-B treatment on the flavonoid profile in kale (*Brassica oleracea* var. *sabellica*)
Coffee BREAK	11.20 – 12.00	
Chairperson	**Prof. Monika Schreiner**	
Round-table discussion	12.00 – 1.30	
LUNCH	1.30 -2.00	
TOUR of UCC	2.00 – 4.00	

Delegates and abstracts

Juan Valverde

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Short biography

Dr. Juan Valverde is Network Scientific Officer of the Irish Phytochemical Food Network (www.ipfn.ie) he holds a BSc on Organic Chemistry from the Universidad Autonoma of Madrid in Spain and **an award winning PhD in Food Science** from the **Academy of Agriculture of France.** Dr. Valverde´s PhD work was conducted in France at the Laboratory of Molecular Interactions (**College de France**) and at Laboratory of Analytical Chemistry (**AgroParisTech**). The PhD was funded by a private ready to eat and convenience foods multinational (Marie-UNIQ) with support of the **French Research Agency** (ANRT).
As network scientific manager of the **Irish Phytochemical Food Network** (www.ipfn.ie), including **over 250 members**, Dr. Valverde has been able to develop a broad **network within Europe and at an International level** with Agro-Food researchers and industries. Naturally this network has lead to the application of EU and other funding opportunities and organization of high media profile scientific symposia (the annual IPFN symposium), seminars and meetings, and coordination and supervision of training courses and international research visits. Dr. Juan Valverde is member of the Phytochemical Society of Europe and the of the French Chemistry Society.

Short institution/company presentation

Irish Phytochemical Food Network

Teagasc is the agriculture and food development authority in Ireland. Its mission is to support science-based innovation in the agri-food sector and the broader bioeconomy that will underpin profitability, competitiveness and sustainability. In particular the Teagasc Food Programme undertakes scientific research leading to the establishment of technological platforms that can be exploited by the Irish Food Processing Industry by adding value and ensures the safety and quality of food products. Since November 2010 a new Bioanalytical facility was opened in the Teagasc Food Research Centre based in Ashtown. This new facility comprises of three state of the art laboratories aimed at extracting and purifying biologically active components (phytochemicals), quantifying their bioactive potential and characterisation of the isolated components.

Irish Phytochemical Food Network: a farm to fork approach to study phytochemicals

Abstract

The Irish Phytochemical Food Network (IPFN) is a network comprised of experts from Teagasc, Dublin Institute of Technology (DIT) and several Irish universities including University College of Cork (UCC), University College of Cork (UCD), National University of Ireland in Galway (NUI Galway) and University of Limerick (UL) and is funded by the Department of Agriculture and Food through the Network and Team Building Initiative of the Food Institutional Research Measure. The main aim of this network is to fill the urgent need to assemble existing knowledge and provide holistic information on the fate of these compounds right up to their site of biological action. The main objectives to implement this network are:

1. To manage and develop an internationally recognised network of researchers on tracing phytochemicals in fruits and vegetables from farm to fork.
2. To develop a world class portfolio of methods to asses the phytochemical and bio-active status of grown fruits and vegetables.
3. To gather existing information and generate new data on the effect of agronomic factors and post harvest storage on the levels of phytochemicals in grown fruits
4. To produce optimised protocols for phytochemicals retention during food processing.
5. To develop a probabilistic exposure models for dietary intake and bio-availability of phytochemicals of Irish grown fruits and vegetables.
6. To generate, screen, develop and test (**GSDT**) innovative ideas for new product development (**NPD**). Investigate consumer attitudes to new innovative products emerging from these studies.

A greater understanding of the roles of phytochemicals in promoting health has already lead to improved formulation of foods and recommendations for consumers concerning the specific contribution made by individual phytochemicals in foods. The new food formulations, accompanied with nutrition and health claims, will increase competition and trade opportunities in Europe.

Outlook of challenges and opportunities for ongoing UV-B research and for realization possibilities

The phytochemical content in plants can be significantly affected by some climatic conditions and in particular photosynthetic photon flux (PPF) and day length (related to UV irradiation), prior to harvest also during the post-harvest and storage conditions.

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Short biography

Tom O'Connor holds a BSc degree in Dairy and Food Science (1980) from University College Cork and a PhD degree in Nutrition (1984) from Cornell University. He then spent three years as a postdoctoral research at Cornell. Afterwards he worked for a major multinational corporation in the US and Belgium before returning to Cork in 1989 to take up a position as a College Lecturer in UCC. He was subsequently promoted to Senior Lecturer. Tom has extensive teaching duties in both Food Science and Nutritional Science. He obtained a President's Award for Teaching Excellence in 2003. He has over 60 research publications. His main interests are related to nutrition in the developing world, the nutrition transition, food toxicology, lipid chemistry and fruit and vegetable processing and quality.

Short institution/company presentation

University College Cork (UCC) is part of the National University of Ireland. It was established in 1845. It has been the principal Irish University in the Food area since the foundation of what was originally the Faculty of Dairy Science in 1926. Subsequently, it developed strong programmes of teaching and research in all key areas of Food Science and Nutritional Sciences. Academic staff has extensive involvement with national and international research programmes and with the food and related industries in Ireland and elsewhere.

Major changes in food consumption trends, the relationship between these and the rise in nutrition related non-communicable diseases (NR-NCD) and the current Dietary Guidelines regarding nutrition and health

Abstract

Prior to 1800, world population was less than 1 billion with less than 10% living in urban environments. In the subsequent two centuries, with the advent of the Industrial Revolution, the Age of Oil, and advances in food production, world population has just surpassed 7 billion with the majority living in urban locations. As countries undergo economic development, several interrelated transitions normally occur – demographic, epidemiological and nutritional. Underdeveloped countries are characterized by high fertility rates and young populations. With economic development, the demographic profile changes to low fertility rates and aging population. The epidemiologial transition relates to the high incidence of infectious diseases as principal causes of mortality in poorer countries; this changes to nutrition related non-communicable diseases (NR-NCD) as principal causes of mortality in developed countries. The nutrition transition involves high incidence of undernutrition in poor countries changing to high levels of overnutrition in developed countries. Several major countries (e.g. China, India, Brazil) currently undergoing rapid economic development have a double burden of both undernutrition and overnutrition. Nutritional Sciences in the developed western societies focused in the earlier part of the 20th century on the investigation and elimination of nutrition deficiencies and establishment of Recommended Dietary Allowances to facilitate these efforts.

Outlook of challenges and opportunities

As the 20th century progressed and western societies became even more economically developed, the incidence of NR-NCD increased significantly (e.g. obesity, type-2 diabetes, vascular diseases, hypertension, certain cancers) leading to the publication of Dietary Guidelines emphasising weight control and increased consumption of plant-derived foods. However, when one looks at food consumption trends over the last several decades, the data indicate increased consumption of meats, sweeteners, vegetable oils, and decreased intake of fruits, vegetables and pulses. These trends correlate with the rise of NR-NCD worldwide.

Marcel Jansen

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Short biography

- 2003-present. University lecturer, School of Biological, Earth and Environmental Sciences (BEES), University College Cork, Ireland
- 2002-2003. University lecturer, Dept. of Plant Physiology, University of Antwerp, Belgium
- 1998-2002. Contract researcher, Dept. of Biological Chemistry, John Innes Centre, Norwich, U.K.
- 1995-1998. Research fellow, Dept. of Plant Physiology, Agricultural University of Wageningen, The Netherlands
- 1993-1995. Post-doctoral research fellow, Dept. of Biological Sciences, Wye College, University of London, U.K.

Major research areas

Plant-ecophysiology with research interests in the functional plasticity of plants under stress, including UV-B radiation, organic pollutants and nano-materials. Research centres on elucidating the molecular-physiological mechanisms underlying adaptation and acclimation responses of plants to hostile environments. UV-B research centres on the mechanism, and ecological role of UV-B induced morphogenic changes, including possible trade-offs in terms of plant fitness. Toxicological work centres on the impacts of nanomaterials on various species of *Lemnaceae*, and addresses the question of the environmental risk of nanoparticles in the environment.

Key UV-B papers

Marcel A.K. Jansen, Bénedicte Le Martret, Maarten Koornneef. Variations in constitutive and inducible UV-B tolerance; dissecting photosystem II protection in *Arabidopsis thaliana* accessions. Physiol. Plant (2009) 138, 22-34.

Kathleen Hectors, Eveline Jacques, Els Prinsen, Yves Guisez, Jean-Pierre Verbelen, **Marcel A. K. Jansen**, Kris Vissenberg, UV radiation reduces epidermal cell expansion in leaves of *Arabidopsis thaliana. J. Exp. Bot* (2010) 61, 4339-4349

Eveline Jacques, Kathleen Hectors, Yves Guisez, Els Prinsen, **Marcel A.K. Jansen**, Jean-Pierre Verbelen, Kris Vissenberg, UV radiation reduces epidermal cell expansion in *Arabidopsis thaliana* leaves without altering cellular microtubule organization. Plant Signaling & Behavior (2010) 6, 1-3.

Amandine Radziejwoski, Kobe Vlieghe, Tim Lammens, Barbara Berckmans, Sara Maes, Marcel Jansen, Claudia Knappe, Andreas Albert, Harald K Seidlitz, Günther Bahnweg, Dirk Inzé, Lieven De Veylder, Atypical E2F activity coordinates PHR1 photolyase gene transcription with

endoreduplication onset. EMBO J. (2011) 30, 355-363.

M.A.K. Jansen (2011) 'UV-B radiation; from stressor to regulatory signal' In: *Plant Stress Physiology* (Shabala, S. ed.), CABI, Oxford.

Short institution/company presentation

UCC was established in 1845 as one of three Queen's Colleges at Cork, Galway and Belfast. The site chosen for the college is particularly appropriate given its connection with the patron saint of Cork, St Finbarr. It is believed his monastery and school stood on the bank of the river Lee, which runs through the lower grounds of the university. The University's motto is "Where Finbarr Taught, let Munster Learn." Some 750 academics, teach some 18.000 students in business and law, science engineering and food sciences, medicine and health, and arts, celtic studies and social studies. One of the University's most famous lecturers was Professor George Boole, (lecturer between 1849-1864) the great mathematician, who is best remembered for his development of Boolean algebra without which modern computer science would be impossible. University College, Cork is now one of four constituent universities of the federal National University of Ireland, and is a leading research institution in Ireland (http://www.ucc.ie/en/about/factsandfigures/).

From stressor to environmental regulator; UV-B induced phytochemicals

Abstract

Kathleen Hectors, Sandra Van Oevelen, Jan Geuns, Yves Guisez, **Marcel Jansen** and Els Prinsen

Plants respond to UV-B exposure by synthesising a broad range of secondary metabolites, including ROS-scavenging antioxidants and UV-B screening phenylpropanoids. Exposure of Arabidopsis thaliana plants to chronic levels of background UV-B radiation stimulates the accumulation of specific flavonol-glycosides, i.e. di- and triglycosylated metabolites of kaempferol and quercetin, some of which were not described in relation to UV protection so far. We have postulated a biochemical pathway for biosynthesis of these triglycosides, involving one single enzyme for the synthesis of all eight metabolites identified. We also show that accumulation of flavonoids is accompanied by altered accumulation patterns for tocopherols, and polyamines. Flavonoids exhibit a slow, steady increase in accumulation, followed by an elevated steady-state. In contrast, polyamines accumulate fast and transiently, which implies a role for these antioxidants in short-term UV responses only. Slightly enhanced levels of the lipid-soluble antioxidant α-tocopherol contribute to UV acclimation. These kinetics demonstrate that the UV-B acclimation process is dynamic, comprising multiple secondary metabolites. The distinct kinetics of different secondary metabolites prove that single-time-point analyses as well as single-metabolite behaviour studies do not necessarily reveal the full extent of a dynamic biological response such as UV acclimation.

Outlook of challenges and opportunities for ongoing UV-B research

Understanding the complexities of UV-B induced metabolite accumulation, in order to assess the potential for exploitation and human health.

Katharina Schoedl[1], Rainer Schuhmacher[2], Astrid Forneck[1]

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Short biography

Katharina Schoedl was born in Mistelbach, Lower Austria. After compulsory school she studied Agricultural Sciences (Bachelor grade) at the University of Natural Resources and Life Sciences in Vienna. Subsequent, she continued her studies in Applied Plant Sciences (Master grade) which she finished with honours in December 2006. The title of her master thesis was „Flower Thinning in Sweet Cherries (*Prunus avium* L.)". In September 2007 she started her doctoral studies as member of the project called "Physiological Fingerprint in Viticulture". In October 2011 she has submitted her thesis with the title "Physiological Assessment and Leaf-Based Biomarkers for UV-B Stress in Grapevine (*Vitis vinifera* L. cv. Pinot noir and cv. Riesling)".
In 2004, Katharina was awarded with a scholarship for honourable merits of the University of Natural Resources and Life Sciences Vienna, in 2008 she got a Junior Grant for the XXIVth International Conference on Polyphenols (Salamanca, Spain, July 2008) from the Groupe Polyphenols and in 2009 she was acknowledged with the award of the "Vinzenz Schumy Ausbildungs- und Förderungsstiftung".

Short institution/company presentation

The University of Natural Resources and Life Sciences, Vienna, the Alma Mater Viridis, sees itself as an education and research centre for renewable resources, which are a necessity for human life. With its wide range of areas of expertise it is the task of BOKU to contribute significantly to the protection of life resources for future generations. With a connection between natural sciences, engineering and economics, BOKU is trying to deepen the knowledge of an ecologically and economically sustainable use of natural resources in a cultivated landscape.

Profiling of target polyphenols in non-treated and UV-B treated grapevine (*Vitis vinifera* L.) leaves

Abstract

Since the postulation of the "French paradoxon" (Renaud and de Lorgeril 1992) and several studies reporting the health benefit effects of wine (as reviewed e.g. by Tomera 1999), the grapevine has raised increased interest in research on secondary metabolites. Wine, grapes and grapevine by-products like leaves or stems have been detected as sources for polyphenols (e.g. Makris et al. 2008) which may serve as biomarkers linked to UV-B stress to facilitate and improve canopy management in commercial vineyards.

Polyphenolic compounds of grapevine leaves have been the objectives of several studies in our group applying the LC-MS/MS methodology (Schoedl et al. 2011). The concentration of sixteen target polyphenols were quantified in non-treated grapevine leaves sampled from various insertion levels of the plant on four sampling dates. The changes of concentration levels induced by application of defined doses of UV-B radiation (greenhouse-based stress assays) were studied in two varieties Riesling (white) and Pinot noir (red) in order to define polyphenolic biomarkers for UV-B radiation impact. Un-treated grapevine leaves of different ages showed to differ in their polyphenolic pattern with the key markers *trans*- and *cis*-resveratrol-3-*O*-glucoside, (+)-catechin, caftaric acid, quercetin-3-*O*-glucoside and quercetin-3-*O*-glucuronide (Schoedl et al. 2011). In UV-B treated leaves selected stilbenes, flavonols and flavan-3-ols showed differences among the applied UV-B treatments. Two quercetin derivatives and kaempferol-3-O-glucoside are postulated as combined biomarker set strengthening the UV-B stress detection potential compared to single compounds (Schoedl et al. 2011).

Outlook of challenges and opportunities for ongoing UV-B research and for realization possibilities

Already established markers are going to be tested for their potential to identify non- and stressed states of grapevines when applied to grapes in an early state of stress, when visual symptoms are far away from being obvious. Special attention is drawn to the recovery potential of the plant after short-time stress impacts.

References

Makris, D., G. Boskou, et al. (2008). "Characterisation of certain major polyphenolic antioxidants in grape (Vitis vinifera cv. Roditis) stems by liquid chromatography-mass spectrometry." European Food Research and Technology 226(5): 1075-1079.

Renaud, S. and M. de Lorgeril (1992). "Wine, alcohol, platelets, and the French paradox for coronary heart disease." The Lancet 339(8808): 1523-1526.

Schoedl, K., A. Forneck, et al. (2011) "Optimization, In-house Validation and Application of an LC-MS/MS Based Method for the Quantification of Selected Polyphenolic Compounds in Leaves of Grapevine (Vitis vinifera L.)." Journal of Agricultural and Food Chemistry DOI: 10.1021/jf202753g.

Schoedl, K., R. Schuhmacher, et al. (2011). "Fingerprinting the polyphenols of Vitis vinifera leaves according to clone, age and insertion level under controlled conditions." Scientia Horticulturae submitted.

Schoedl, K., R. Schuhmacher, et al. (2011). "Leaf-based biomarkers for UV-B stress in Vitis vinifera L. cv. Pinot noir and Riesling." in preparation.

Tomera, J. F. (1999). "Current knowledge of the health benefits and disadvantages of wine consumption." Trends in Food Science & Technology 10(4-5): 129-138.

Richard Mithen

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Short biography

Professor Richard Mithen is currently Head of the Food and Health programme at the Institute for Food Research. Richard obtained a PhD at the University of East Anglia, and then spent three years working for the International Board for Plant Genetic Resources in southern and eastern Africa. From 1989 he was a research group leader at the John Innes Centre, prior to becoming Professor of Crop Science at the University of Nottingham in 2000. In 2003 he moved to the Institute of Food Research in Norwich. His research is focussed on the health prompting effects of dietary phytochemicals, with his major interest being in the role of glucosinolates and their degradation products in cruciferous vegetables in preventing chronic disease.

Short institution/company presentation

IFR is a world leader in research into harnessing food for health and preventing food-related diseases. It is the only institute in the UK wholly dedicated to the food science, diet and health agenda. Our scientists address the UK's Grand Challenges of obesity and healthy ageing by defining the relationship between food, diet and health, and they are making a vital contribution to the food security agenda. We undertake internationally-ranked fundamental, strategic and applied research with high socio-economic impact, making a real difference to quality of life. Our research activities are divided into two programmes, Gut Biology and Health, and Food and Health. The latter deals with the role of food bioactives, including polyphenols and glucosinolates, the biophysics of food structure and how it influences release of nutrients and bioactives in the gut, and the processing of agri-food waste streams for the extraction of high value products and bioethanol production.

Broccoli, glucosinolates and health

Abstract

I will provide an overview of the evidence from epidemiological studies and the use of cell and animal models that diets rich in cruciferous vegetables and glucosinolates can prevent and reduce the progression of chronic diseases, with the emphasis on cardiovascular disease and prostate cancer. I will describe the development of high glucosinolate broccoli cultivars and the important role of the myb28 transcription factor in regulating glucosinolate biosynthesis. I will summarize the results of a dietary intervention study with high glucosinolate broccoli on biomarkers of cardiovascular health. I will conclude with some recent data on the regulation of myb28 expression by UV radiation and its consequence for glucosinolate accumulation in broccoli florets

Outlook of challenges and opportunities

Exemplarily shown by broccoli, I will show opportunities to create plant-based functional food.

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Claudia Scattino was born in Orvieto (Italy) on June 1984.
In 2006 she received her bachelor's degree in Agricultural and Industrial Biotechnology at the Agriculture Faculty of the University of Pisa and she did an internship at the “Istituto Zooprofilattico” of Lazio and Tuscany in Pisa. In 2009 she obtained her master’s degree in Food Biotechnology with a research thesis entitled “Response of secondary metabolism in grapes subjected to partial dehydration and post-harvest treatments with gaseous elicitors“.
In 2009 she obtained a collaboration agreement to work at the project “Study of the secondary metabolism of Sangiovese and Trebbiano grapes subjected to partial dehydration and different post-harvest treatments with gaseous elicitors: ethylene and CO_2”.
Since 2010 she is a student at the PhD School of Agricultural and Veterinary Sciences (Crop Sciences Program) of the University of Pisa. She is receiving a scholarship from Sant'Anna School of Advanced Studies of Pisa.
Her PhD research is focused on studying the effects of UV-B post-harvest treatments on the secondary metabolism and on cell wall enzymes in different peach cultivar.
She is conducting her activity under the supervision of Prof. Annamaria Ranieri and Prof. Pietro Tonutti at the Department of Crop Biology of the University of Pisa.

The Agriculture Faculty of the University of Pisa was definitively established in 1871 and could be considered as the first academic institution in the world for agrarian studies. Within the Agriculture Faculty, the Department of Crop Biology, established in 1987, has a number of laboratories, experimental facilities at the highest level of expertise in the disciplines of genetics, microbiology, agricultural industries, chemistry and agricultural and ornamental crops that are used both for educational purposes and also to carry out research and analysis consulting services on behalf of private and public entities.

Polyphenolic profiling in two cultivars of peaches treated in post-harvest with UV-B radiations

Fruits and vegetables are considered excellent functional foods thanks to their high content of antioxidant compounds. Peaches and nectarines, of which Italy is the first European and second worldwide producer, are nutritionally important fruits being among the most consumed all over the world. Polyphenols are the main source of antioxidant power in peach fruits. This class of secondary metabolites includes a variety of compounds such as hydroxycinnamic acids, flavan-3-ols, gallic acid derivatives, flavonols and anthocyanins. These molecules have a preventive action in the development of degenerative diseases and are crucial in the management of commercial quality of fruits, participating in the color and taste determination.

The aim of our work was to investigate if the use of UV-B radiation (1,68 W/m^2) during the first 36 hours after the harvest, could influence the content of the main phenolic compounds, in peel and pulp tissues, of two peach cultivar: Suncrest (“melting” flesh) and Babygold 7 ("non melting" flesh).
On both cultivar, the content of phenols, total flavonoids, flavan-3-ols and flavonols after the post-harvest UV-B treatment was assessed by spectrophotometric analysis. The identification and quantification of individual phenolic compounds was conducted by LC-ESI-MS. Furthermore, the ethylene emission was monitored by GC throughout the duration of treatment.
Significant differences were found comparing the two cultivars, regarding the total content of each class of compounds and in their response to the treatment.
Suncrest peaches showed higher levels for all tested polyphenols compared to Babygold 7 fruits, both in peel and flesh. Suncrest peel, after 36 hours of irradiation, showed a significant increase in the secondary metabolites in the fruits treated with UV-B compared to control ones. Babygold 7 peaches, in contrast, showed a low sensitivity to UV-B post-harvest treatment.

Outlook of challenges and opportunities for ongoing UV-B research and for realization possibilities

UV-B radiation could be used as an effective “environmental friendly” tool to manage the postharvest quality of fruit and vegetables. Our results suggest a significant effect of this radiation in limiting the loss of nutraceutical compounds during the first hours after the fruits collection.

Johann Martínez Lüscher

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Short biography

I graduated in Environmental and Agricultural Biology in 2006 at the University of Navarra, where I did an internship at the Department of Plant Biology. During that period I did also an internship at the USDA evaluating the success of environmental restoration projects in the Chesapeake bay (MD, USA) using marsh grasses. Next I moved to Denmark where I did a Master in Environmental Sciences at the University of Southern Denmark (Odense, Denmark) with a master thesis about seagrass ecophysiology, and thanks to it, I published my first article. Now I´m doing a PhD. thesis entitled "**Effect of UV-B radiation on grapevine (*Vitis vinifera* cv. Tempranillo) physiology and the synthesis of phenolic compounds in the berry"**, under a joint supervision of the University of Navarra and the Institut des Sciences de la Vigne et du Vin.

Short institution/company presentation

The **Universidad de Navarra** is well known for the excellence of its teaching and research and the quality of its graduates. At the Center of Applied Medical Research (CIMA), four lines of investigation in oncology, neurosciences and gene therapy are covered by 350 researchers. The University Hospital; the Guipúzcoa Center of Technical Studies and Research (CEIT); the Research Plan of the University of Navarra, and the Navarra Institute of Science and Technology, all of them contribute to make research the cornestone of the University.

The **School of Sciences** of the Universidad de Navarra was founded in 1959, and is the third oldest school in Spain which trains professionals in Biology. It maintains close relations with the School of Medicine and Pharmacy as well as with the University Hospital. Currently there are 1163 students in Biology, Chemistry or Biochemistry program degrees. The ratio of one professor for each six students make this personal attention possible

The **Section of Plant Biology**. Associated Unit with Spanish National Research Council, CSIC (Aula Dei Experimental Station, Zaragoza; Institut of Vine and Wine Science, Logroño), performs research and teaching activities in the School of Sciences and Pharmacy. It develops research projects both in basic and applied aspects in Plant Physiology, Plant Biotechnology and Plant Pathology. There are 7 research laboratories in the Section, conducting research in the following lines:

- Effect of climate change on plants
- Biology of grapevine
- Plant responses to abiotic and biotic stress factors
- Arbuscular mycorrhizal fungi in natural and agricultural ecosystems
- Organic waste management Agricultural use of sewage sludge

Influence of UV-B on phenolic compound biosynthesis in grape berry skin

Abstract

As a general response to UV-B radiation plants accumulate phenolic compounds (anthocyanins, flavonols and stilbens), which protect plant tissues against cell damage. These compounds are important constituents of grapes, due to their impact on the organoleptic properties of wine and their health-promoting effects. Nevertheless, the global effects of UV-B radiation on the grape berry composition still need further investigation. Moreover, the response of plants to UV-B radiation may be conditioned by other environmental factors such as temperature, atmospheric CO_2 concentration or water availability.

The aim of the present project is to study the effect of UV-B radiation in interaction with other environmental factors (temperature, atmospheric CO_2 concentration and water availability) on the physiology of grapevine, focusing on the grape berry composition (phenolic compounds and amino acids). The experiments will be performed with grapevine fruiting cuttings (Vitis vinifera cv. Tempranillo) under greenhouse controlled conditions. A first experiment was conducted in order to elucidate the effect of three doses of UV-B radiation (0.7 and 11 kJ m^{-2} d^{-1}) applied from two stages of grape maturation: fruit set and véraison. In this experiment flavonols, anthocyanins and amino acids profiles were determined by HPLC. Hence, UV-B treatements induced an increase in total flavonols when applied from fruit set, whereas total anthocyanins and amino acids remained unchanged. UV-B also increased the skin: pulp ratio.

Acknowledgements: *Fundación Universitaria de Navarra, Asociación de Amigos de la Universidad de Navarra, Fondo de Cooperación Transfronteriza Navarra-Aquitania,* UV4growth COST Action FA0906 and *Gobierno de Aragón (grupo de investigación A03).*

Outlook of challenges and opportunities for ongoing UV-B research and for realization possibilities

Study how the quality-related metabolites are produced in wine grapes under UV-B radiation with a gene expression approach.

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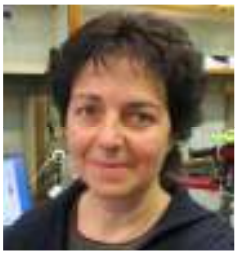

Short biography

education, degrees:

1983 – graduated as physicists, University of Szeged, Hungary
1986 – Dr. Univ. plant biochemistry, University of Szeged, Hungary
1989 – C.Sc. (Ph.D.), Hungarian Academy of Sciences
1997 – Prof. Habil., University of Pécs, Hungary
2003 – D.Sc., Hungarian Academy of Sciences

affiliations:

1983 – 2011, Biological Research Centre of the Hungarian Academy of Sciences, Szeged
(2011 – research advisor, part time)
2011 – professor
University of Pécs, Faculty of Sciences, Institute of Biology, Department of Plant Physiology

research interests:

1983 – 1989: charge separation and recombination in Photosystem II of photosynthesis
1988 – 1991: ultraweak light emission from plants (Inaba Biophoton Project, Japan)
1991 – 2000: photoinhibition of photosynthesis by excess PAR or UV-B radiation
1991 – : reactive oxygen detection in plants, EPR (1993 – 1998) and fluorescent (1996 –) ROS traps
2002 – : oxidative stress, abiotic stress in leaves
2008 – : antioxidant / pro-oxidant balance during acclimation to sunlight and various abiotic factors

list of publications:

http://mycite.szbk.u-szeged.hu/search/index.php

Short institution/company presentation

The modern **University of Pécs** (UP) was founded on 1 January 2000 through the merger of Janus Pannonius University, the Medical University of Pécs and the Illyés Gyula Teacher Training College of Szekszárd. However, its roots go back to 1367 when the Anjou king Louis I of Hungary established the first university of the country here (more at http://english.pte.hu/). At present, UP has ten faculties, more than 29,000 students and nearly 2,000 teaching and research staff.
One its ten faculties, the **Faculty of Sciences** (http://ttk.pte.hu/english/) was established on January 1, 1992. The seven institutes constituting the Faculty have around 3,000 students and ca. 140 full-time teaching and research staff. In addition to BSc and MSc training, the Faculty offers PhD studies at four Doctoral Schools (Biology, Chemistry, Geography and Physics).
The present **Institute of Biology** (http://ttk.pte.hu/biologia/biology.htm) consists of seven departments: Animal Ecology, Botany, General Zoology, Genetics, Microbiology, Neurology and Plant Physiology. Research at the **Department of Plant Physiology** includes phytochemistry (grapevine polyphenols), plant molecular biology (BABA-induced priming, gene silencing in Arabidopsis) and leaf stress physiology (energy dissipation vs. antioxidant responses during stress and acclimation in tobacco and grapevine). The Department has several joint projects with the

Institute of Viticulture and Oenology of UP.

Sweet and helpful stuff: carbohydrate-containing biomolecules as potential antioxidants

Abstract
In addition to 'classic' antioxidants such as ascorbate, flavonoids or GSH other cell components may also be contributing to altering reactive oxygen (ROS) levels in plants. Using methods suitable to evaluate specific ROS neutralizing capacities (including our own ones: Šnyrychová & Hideg 2007; Majer et al. 2010) we studied a number of sugars and sugar derivatives as potential antioxidants. These *in vitro* measurements concentrated on reactivity to the following ROS: superoxide anion radicals, hydrogen peroxide, hydroxyl radicals. It was found that inulin and stevioside are superior scavengers of both hydroxyl and superoxide radicals, both more reactive to $^{\bullet}OH$ than mannitol (Stoyanova et al. 2011). In general, poly-saccharides appeared better ROS neutralizers than more simple compounds no general structure-function relationship was found. This in vitro work was done at the Biological Research Centre (Szeged, Hungary) in collaboration with Wim Van den Ende (Catholic University of Leuven, Belgium) (Stoyanova et al. 2011).
A possible new dimension of the above study is to explore is whether carbohydrate-containing biomolecules may contribute to plant responses to UV radiation. Some preliminary results will be presented, including ROS scavenging capacity measurements on extracellular washing fluid and residual leaf extracts prepared from broad bean leaves. Samples from plants grown under low supplementary UV-B (doses not damaging photosynthetic activity) were compared to those from plants grown in the same green-house but in the absence of UV-B.

Details of our experimental techniques can be found in:
Majer P, Stoyanova S, Hideg É (2010) J Photochem Photobiol B 100:38-43
Šnyrychová I, Hideg É (2007) Funct Plant Biol 34:1105-1111
Stoyanova S, Geuns J, Hideg É, Van den Ende, W (2011) J Food Sci Nutr 62:207-214

Outlook of challenges and opportunities for ongoing UV-B research and for realization possibilities
Carbohydrate-containing biomolecules as potential antioxidants could worth exploring from a plant physiological point of view, as potential contributors to ROS mediated acclimation. On the other hand, this possibility could also be interesting from the consumers' / breeders' point of view: whether changes of sweet tasting compounds accompany (intensify? balance? complement?) those of bitter ones (e.g. flavonoids).

Matthijs Dekker

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Dr. Matthijs Dekker is Associate Professor of Food Technology at Wageningen University, The Netherlands. He obtained his PhD in Food Engineering from this university in 1990. He joined Unilever Research Laboratory in The Netherlands in Food and Bioprocess Engineering research for five years. He returned to Wageningen University in 1995 to the Product Design and Quality Management Group in the department of Agrotechnology and Food Sciences. His research interest is mainly on the effect of process and product design on health aspects of foods, food packaging and consumer oriented product design with a special interests in mathematical modelling in Food Science. He has over 60 peer-reviewed publications and sat on many international grant review boards. He was Chairman of EU-COST action 926: “Impact of new technologies on the health benefits and safety of bioactive plant compounds”. He is currently Workpackage leader of the EU-FP7 project DREAM: Development of REAlistic Models for food (WP2 on plant foods). He is member of the Health Council Advisory Committee on health logo’s and of the Advisory Board for the evaluation of novel foods.

Wageningen University was founded in 1918. In recent decades it has evolved into one of the world’s leading education and research centers in the plant, animal, environmental, agrotechnological, food and social sciences. Its mission is stated as: "Wageningen University wishes to develop and disseminate the scientific knowledge needed to sustainably supply society’s demand for sufficient, healthy food and a good environment for humans, animals and plants". The research of the Product Design and Quality Management Group is focused on assessment and modelling of product quality and the changes occurring within foods during storage and processing.

Bioactive components in plant foods; Results and opinion of the EU-COST926 action

Abstract

This presentation reviews the main results of EU-action: COST 926 on the health benefits and safety of bioactive plant compounds. The action’s aim was to ensure that maximum benefit for public health and competitiveness of the food and related industry is gained in the study of bioactive components in fruits and vegetables in relation to disease prevention.
The project was organized in four topics:

- Recently introduced molecular tools
- Gene expression and disease
- Phytochemicals and gene expression
- Bioavailability of phytochemicals including the effect of processing

The action published a dozen review papers dealing with the bioavailability and health effects of: carotenoids, flavonoids, glucosinolates, phytoestrogens, tannins and phytic acid. The main findings of these reviews will be presented.

New research technologies (‘omics’) enable us to address these issues by monitoring patterns of gene expression in humans and to provide essential molecular biomarkers of early disease. By combining such data with knowledge of the dietary exposure and bioavailability of the most effective compounds it will be possible to predict the most effective dietary sources and to properly evaluate the potential role of many phytochemicals for human health in food products.

The further use of ‘omics’ research will result in an enormous increase of our knowledge of the effects of phytochemicals on human health. Individual variation between humans will be addressed in more detail to allow for personalized nutrition.

Effective delivering of important phytochemicals to consumers will require the optimization of supply chains ‘from farm to fork’. The current supply chains result in a large variability in levels of selected phytochemicals in plant products that are consumed. Developing new cultivars with optimized profiles of phytochemicals should be combined with improved food processing in industry and preparation by the consumer to optimize the bioavailability of the selected compounds.

Petra Majer

Staff Scientist
Institute of Plant Biology, Biological Research Centre of the Hungarian Academy of Sciences, Szeged, Hungary

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Short biography

Education

2006 MSc Degree in Horticultural Sciences, Corvinus University of Budapest, Hungary
2008- PhD student in Biology, University of Szeged

Positions

2006-2008 Research Assistant, Cereal Research Non-Profit Ltd., Szeged
2008- PhD student, Institute of Plant Biology, BRC, Szeged
2011- Staff Scientist, Institute of Plant Biology, BRC, Szeged

Studies and research abroad

2011 February (2 weeks): COST research grant, Institut für Gemüse- und Zierpflanzenbau Großbeeren/Erfurt e.V., Großbeeren, Germany
2005 (4 months): Erasmus grant, École Supérieure d'Agriculture d'Angers (ESA), Angers, France

Research interest

Reactive oxygen species, Antioxidant / pro-oxidant balance during acclimation to sunlight and various abiotic factors (high light, UV-B)

Scientific results

Number of publications: 6 (4 peer reviewed journal articles, 2 conference proceedings)
Cumulative IF: 9.23
Number of citations : 5

Short institution/company presentation

The Biological Research Centre is the largest research facility of the Hungarian Academy of Sciences, founded in 1971. Its activity covers all areas of modern biology. It is organized into four institutes, corresponding to the diversity of the investigated fields: the Institutes of Biophysics, Biochemistry, Genetics and Plant Biology. The activities of the Center involve primarily basic science, but practical application of the results also represents a high priority. The research topics include several fields of molecular and cell biology from the industrial utilization of bacteria through controlled improvement of cultivated plants to the problems of human health and environmental protection. BRC is mainly a scientific basic research centre, but scientists of BRC play an initiative role in the foundation and promotion of biotechnological companies, as well as in educational duties. The successful activity and high-level scientific research pursued in BRC were also acknowledged by the European Molecular Biological Organization (EMBO) and in 2000 the European Union awarded the title of "Centre of Excellence" to BRC.
http://www.brc.hu/

Living under the sun: singlet oxygen neutralizing by flavonoids in sun and shade linden leaves

Abstract

Leaves grown in natural sunlight are capable of adapting to high photosynthetically active radiation (PAR) and ultraviolet (UV) radiation. When adaptive defence mechanisms are overloaded excess irradiance may result in the production of singlet oxygen ($^1O_2$) and other reactive oxygen species (ROS). Leaves can protect themselves from this photoinhibitory effect by dissipating excess energy and thus preventing ROS formation or by scavenging ROS.
Contributions of these two major photoprotective pathways were studied in fully-developed sun- and shade-leaves of a large-leaved linden tree (Tilia platyphyllos L.).
We found that sun-leaves had approx. 5-fold better specific $^1O_2$ antioxidant capacity than shade-leaves, which can be explained by their higher flavonoid contents. In sun-leaves quercetin and kaempferol were present in much higher concentrations than in shade-leaves. Myricetin was also present but in smaller amounts in both types of leaves. Our specific $^1O_2$ antioxidant test showed that all three flavonoid aglycons have strong scavenging capacities *in vitro*, in a myricetin > quercetin > kaempferol order, according to the number of their hydroxyl groups. Growth in sunlight raised the quercetin : kaempferol ratio significantly.
In addition to more effective $^1O_2$ neutralizing, sun-leaves had stronger regulated non-photochemical quenching which shade-leaves failed to activate when exposed to higher PAR than their growth light.
Our findings show that adaptive tolerance to high light and UV of linden leaves depends both on efficient dissipation of excess energy and on $^1O_2$ neutralizing capacity, with the flavonoids having an important role in this latter.

Outlook of challenges and opportunities for ongoing UV-B research and for realization possibilities

Changes in the antioxidant defense system are important to follow not only during stress conditions but also when plants are exposed to environmental UV-B doses (or environmentally relevant doses in green-house experiments) to gain a more profound understanding of acclimation responses.

Inga Mewis

Research Associate, Quality Department
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Fax +49 (0)33701-55391
E-mail: inga@entomology.de

Educational background

1998 Diploma in Biology, Free University Berlin, Germany

2001 PhD. in chemical ecology and entomology, Free University Berlin/Technical University Munich, Germany. Cooperation with Central Luzon State University, Philippines

Professional experience

2001 – 2004 Postdoctoral Fellow in the Chemical Ecology Lab., Department of Entomology, Pennsylvania State University, USA.

2003/04/05 Visiting Scientist, Max-Planck Institute for Chemical Ecology (MPI), Jena, Germany.

2004 – 2009 Research associate and lecturer, Humboldt University Berlin, Faculty for Agriculture and Horticulture, Division Urban Plant Ecophysiology

Major research areas

Chemical plant defence and integrated pest management: I am interested in chemical compounds which mediate ecological interactions of herbivores, pathogens, and plants and how they are influenced by abiotic factors such as UV-B and water stress. Here I am focussing on the plant defensive response to different specialized insect herbivores and implications of changes within secondary metabolites on human health.

Key papers

Mewis, I., Appel, H.M., Hom, A., Raina, R. & Schultz, J.C. (2005): Major signaling pathways modulate *Arabidopsis thaliana* (L.) glucosinolate accumulation and response to both phloem feeding and chewing insects. Plant Phys 138 (2): 1149-1162.

Mewis, I., Tokuhisa J.G., Schultz, J.C., Appel, H.M., Ulrichs, Ch. & Gershenzon, J. (2006): Gene expression and glucosinolate accumulation in *Arabidopsis thaliana* signaling mutants in response to generalist and specialist herbivores of different feeding guilds and the role of defense signaling pathways. Phytochemistry 67: 2450-2462.

Schreiner, M., Huyskens-Keil, S., Mewis, I., Ulrichs, Ch. & Krumbein, A. (2009): Glucosinolates in crucifer species affected by postharvest elicitors – altered gas composition and UV-B irradiation. Acta Hort 867: 53-59.

Baasanjav-Gerber, C., Monien, B. H., Mewis, I., Schreiner, M.; Barillari, J., Iori, R. & Glatt, H. R. (2010): Identification of glucosinolate congeners able to form DNA adducts and to induce mutations upon activation by myrosinase. Mol Nutr Food Res 55: 1-10.

Short institution presentation

The Leibniz-Institute of Vegetable and Ornamental Crops Großbeeren/Erfurt e.V. (IGZ) works on the scientific base of ecologically meaningful and also effective production of horticultural products. Horticultural products should be of high quality, originated by an environmentally friendly cultivation and have to meet the consumer's demands. Vegetable plants are the basis for a valuable diet and various food trends as vegetable-based food can both: taste well and be healthy. Thereby our research supports sustainability, competitiveness of growers and tailored vegetable quality according to consumer desires.
Regarding consumer preferences in vegetable products, elicitor treatments may be used to obtain vegetables enriched with secondary plant metabolites for sale as fresh market products or used as bioactive additives for functional foods and supplements, thereby promoting higher consumption of these health-promoting substances.

Similarities in host-plant defense induced by UV-B and fungal pathogens

UV-B effects on plant biochemistry have been often associated with increases in phenolic compounds. However, little is known about UV-B mediated changes on other non-volatile secondary metabolites in Brassicaceae which contribute to the plant defense against their enemies and may be beneficial for human nutrition. Ecological relevant UV-B doses ($0.3 – 1$ kJ m^{-2} d^{-1}) were applied to *Brassica oleracea* var. *italica* (broccoli) sprouts and *Arabidopsis thaliana.* Treatments elicited especially the accumulation of 4-methoxy-indol-3-ylmethyl glucosinolate and 4-methylsulfinylbutyl glucosinolate. In *A. thaliana*, UV-B induced pronounced increases in levels of the phytoalexin camalexin, which is known to be responsive to necrotrophic pathogens. The UV-B mediated accumulation of defensive metabolites had similarities to the plant response induced by the pathogens *Botrytis cinerea* and *Alternaria brassicicola*. The accumulation of secondary metabolites in broccoli and *A. thaliana* were related to transcriptional responses in microarray analyses. Corresponding to the accumulation of defensive metabolites, transcript of genes associated with salicylate and jasmonic acid signaling pathways increased. Interestingly, the UV-B induced up-regulation of the most responsive genes in broccoli sprouts was very similar to plant response induced by fungal and bacterial pathogens. Furthermore, the *Brassica* microarray data revealed a remarkable UV-B mediated induction of potential genes orthologous to genes of *A. thaliana* which are involved in the biosynthesis of camalexin.

Outlook of challenges and opportunities for ongoing UV-B research and for realization possibilities

UV-B-mediated changes on bioactive secondary metabolites should be studied along with other abiotic and biotic stressors in model plants belonging to Brassicaceae. Stress mediated alteration of micronutrients should be evaluated with implication on human health.

Susanne Huyskens-Keil

Head of the Section Quality Dynamics/Postharvest Physiology at Humboldt-Universität zu Berlin

Humboldt-Universität zu Berlin
Division Urban Plant Ecophysiology
Section Quality Dynamics/Postharvest Physiology
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Short biography

1985 Diploma Agricultural Engineering (Dipl.-Ing. agr.) Rheinische-Friedrich-Wilhelms University Bonn, Germany)
1986 Research Assistant, Institute for Fruit and Vegetable Production, University Bonn, Germany
1987-1991 Research Assistant and PhD (Dr. agr.)
The Institutes for Applied Research, Ben Gurion University of the Negev, Israel and Institute for Fruit and Vegetable Production, University Bonn, Germany
1989 Coordinator of the project "Germplasm collection and diversification of cucurbitaceous crops",Evaluation of new crops for export Markets, Moi University Nairobi, Kenya
1992-1993 Senior Scientist
Technical University Berlin, International Agricultural Development, Germany
Since 1993 Senior Scientist, Head of the Section Quality Dynamics/Postharvest Physiology, Faculty of Agriculture and Horticulture, Humboldt-Universität zu Berlin, Germany

Major areas in research and teaching in the field of pre- and postharvest quality dynamics of horticultural products (lectures in study courses: BSc Horticultural Science, BSc Agricultural Science, MSc Process- and Quality Management, MSc International Horticultural Sciences)

Short institution/company presentation

The Section Quality Dynamics/Postharvest Physiology is established at the Division Urban Plant Ecophysiology of the Faculty of Agriculture and Horticulture, Humboldt-Universität zu Berlin, Germany. The Division Urban Plant Ecophysiology addresses questions about the control over growth, reproduction, survival, abundance, geographical distribution, and quality of plants in pre- and postharvest, as these processes are affected by their environment. Plants are not able to escape unfavorable and changing environmental factors such as heat, cold, drought or floods and therefore must endure the adverse conditions or perish. Plants are therefore adapting to changing conditions. Adaptations to harsh environments, typical for urban environments, influence plant metabolism and plant nutritional value. The division consists of three research and teaching sections: Section Quality Dynamics/ Postharvest Physiology, Section Chemical Ecology and Section Plant Nursery.

Research fields of the Section Quality Dynamics/Postharvest Physiology

- Quality dynamics of fruits and vegetables of temperate and tropical/subtropical origin during entire food supply chain (from production until consumer)
- Postharvest physiology (ecophysiological impacts e.g. drought stress, UV, ozone on structural carbohydrates and cell wall metabolism as well as health-promoting primary and secondary plant compounds)
- Postharvest technology (impact of chemical and physical elicitors on textural properties, hygienic status, and primary and secondary plant compounds with health-promoting characteristics; postharvest treatments)

Interactive effects of drought stress and UV-B radiation on plant responses and secondary metabolites in lettuce (*Lactuca sativa* L.)

Abstract

Global climate change comprises changes in the impact of multiple environmental factors on plant physiological reaction and adaptation mechanisms. There are many reports on potential consequences of UV-B radiation and drought stress for plants, but there is still a rather limited understanding of their interactive effects on plant responses in terms of health promoting secondary plant metabolites, especially in vegetables during production and postharvest. It is known that UV radiation as well as drought stress might induce stress and thus, activate plant defence system, leading to an accumulation of secondary plant metabolites in plant tissue. However, information on the synergistic or antagonistic effect of multiple stresses is scanty, i.e. responses of plants to UV-B and water limitations might decrease or increase its sensitivity towards the stressor.

The present investigation focused on plant responses of vegetables, i.e. lettuce (*Lactuca sativa* L.) to different water regimes (water-deficit (25% water capacity), well-watered (45%), water-logged (75%) in combination with UV-B radiation levels (0.075 and 0.15 Wh m^2). The aim was to evaluate and assess the multiple impacts of UV-B and drought stress induced changes in morphological and physiological characteristics of lettuce, especially in terms of the dynamics of enzyme mediated profiles of health promoting secondary compounds (carotenoid and flavonoid pattern) during postharvest. This study revealed a diverse reaction pattern of lettuce towards the different stressors, however in general, the synthesis of flavonoids, e.g. luteolin and quercetin, were predominantly promoted by single than by multiple factors. An overview of important results will be presented and discussed in detail.

Outlook of challenges and opportunities for ongoing UV-B research and for realization possibilities

Studying the dynamics of secondary metabolite response of plants and its interaction to multiple stressors (UV radiation, drought etc.)

Eva Rosenqvist

Associate Professor
Department of Agriculture and Ecology/Crop Science, Copenhagen University

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Short biography

Plant physiologist specialized in stress effects on photosynthesis as shown in gas exchange and modulated chlorophyll *a* fluorescence. I have been working on climate control in greenhouse production since 1992 and have developed a dynamic climate control system, IntelliGrow, where the temperature and CO_2 concentration is controlled by the natural irradiance via models of how photosynthesis responds to the three climate parameters. Utilizing the free heat from the sun it allows energy savings of 10-40%, depending on the crop species (ca. 40 ornamental and two vegetable species tested), by just programming the climate computer in a different way than in a traditional, stable climate.

During my 15 years at Department of Horticulture, the Danish Institute of Agricultural Sciences, I got extensive experience in projects where greenhouse nurseries were direct project partners. Since 2007 I work as Associate Professor in protected cultivation at Department of Agriculture and Ecology at Copenhagen University, where recent projects include LED light for ornamental plant production, thigmomorphogenesis to reduce stem elongation in pot roses and UV-B to induce vitamin D_2 in button mushrooms.

My core MSc course is Climate Management in Horticultural Production, where we link basic climate physics to the technical possibilities to modify the climate parameters in greenhouses and in the field, and what physiological processes we want to affect by doing so. I also teach plant ecophysiology and calibrated workflow in Photoshop for scientific documentation.

Short institution/company presentation

At Section of Crop Science, Department of Agriculture and Ecology, Copenhagen University, we study and teach the sciences related to crop interactions between G(enotype), M(anagement) and E(nvironment). We work to acquire, integrate and disseminate basic and applied knowledge about field and horticultural crops and cropping systems in an ever-changing world.

We have five research groups; Crop Production and Production Systems; Biosystems, Climate and Technology; Weed Biology and Management; Horticultural Science; and Danish Seed Health Centre.

Plant research with end users in the horticultural production industry; what can we do with UV-B?

Abstract

Implementation of results from basic research in commercial plant production does not happen automatically – a number of conditions have to be fulfilled. For UV-B research the primary end users are in the horticultural greenhouse industry, since they are the only growers that actively can modify the radiation spectrum by cover material or lamps. The industry ranges from backyard plastic tunnels with farm sales of bedding plants to high-tech vegetable greenhouses where every aspect of the environment is controlled for optimal production. To facilitate implementation in commercial production it is important to get an understanding for the production system, to be able to offer doable solutions.

From the producers perspective there has to be a clear benefit of implementing new findings. Parameters that count for greenhouse growers are e.g. increased yield, reduced use of pesticides and improved crop quality that can be used for branding, but these compete with reducing labour costs and energy use. The bottom line for any nursery is to cut costs or increase the earning through increased price or sales, i.e. the investments for implementing new techniques has to pay off economically, unless they are cost neutral.

For UV-B research in protected cultivation we are talking about re-establishing the UV-B radiation that is removed by traditional greenhouse cover materials. The effect on secondary metabolites, antioxidants and pigments will be the primary results to explore in vegetable production, but the improved colouration and growth retardation for more compact ornamental plants is also of commercial interest. Fungicidal effects of UV-B will be worth investigating since fungal disease is an important quality problem for many crops. To have the results implemented, however, the research has to be done under comparable growth conditions in greenhouses, and not in climate chambers.

Outlook of challenges and opportunities for ongoing UV-B research and for realization possibilities

One challenge when using UV-B *lamps* for vegetables is to convince the authorities that you recreate *natural radiation* to e.g. increase the vitamin D_2 level in button mushrooms, not doing something new that needs approval as Novel Food under EU's food safety regulation.

Susanne Neugart (nee Schmidt)

Ph.D. student
Leibniz-Institute of vegetable and ornamental crops
Grossbeeren/Erfurt e.V.

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14979 Großbeeren
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Fax: +49 (0)33701-55391
Email: neugart@igzev.de

Short biography

I have studied nutritional sciences at the Friedrich Schiller University Jena. Since my diploma thesis I work in the field of flavonoids and their response to different environmental factors such as nitrogen-fertilization, temperature and radiation. As a Ph.D. student I work in a DFG funded project. The main focuses were to identify the structures of different flavonoid glycosides in kale and to investigate the structure-specific response to temperature and radiation. The results of this project were presented in several papers and oral presentations. In cooperation with other institutes such as the Technische Universität Berlin, the Humboldt Universität in Berlin, the China Agricultural University in Beijing or the Biological Research Centre in Szeged I worked on the identification of flavonoids in legume (bean), deciduous trees (linden) and model plants (tomato and *Arabidopsis thaliana*).

Key Papers:

Susanne Schmidt, Michaela Zietz, Monika Schreiner, Sascha Rohn, Lothar W. Kroh, Angelika Krumbein. 2010. Genotypic and climatic influences on the concentration and composition of flavonoids in kale (Brassica oleracea var. sabellica).Food Chemistry. 119.1293-1299

Michaela Zietz, Annika Weckmüller, **Susanne Schmidt**, Sascha Rohn, Monika Schreiner, Angelika Krumbein, Lothar W. Kroh. 2010. Genotypic and Climatic Influence on the Antioxidant Activity of Flavonoids in Kale (Brassica oleracea var. sabellica). Journal of Agricultural and Food Chemistry 58. 2123–2130

Susanne Schmidt, Michaela Zietz, Monika Schreiner, Sascha Rohn, Lothar W. Kroh, Angelika Krumbein. 2010. Identification of complex, naturally occuring flavonoid glycosides in kale (Brassica oleracea var. sabellica) by high-performance liquid chromatography diode array detection/electrospray ionization multi-stage mass spectrometry. Rapid Communications in Mass Spectrometry. 24. 2009-2022

Susanne Neugart, Michaela Zietz, Monika Schreiner, Sascha Rohn, Lothar W. Kroh, Angelika Krumbein. 2011. Structurally different flavonol glycosides and hydroxycinnamic acid derivatives respond differently to moderate UV-B radiation exposure. Physiologia Plantarum. accepted

Short institution/company presentation

The Leibniz-Institute of Vegetable and Ornamental Crops Großbeeren/Erfurt e.V. (IGZ) works on the scientific base of ecologically meaningful and also effective production of horticultural products. Horticultural products should be of high quality, originated by an environmentally friendly cultivation and have to meet the consumer’s demands. Vegetable plants are the basis for a valuable diet and various food trends as vegetable-based food can both: taste well and be healthy. Thereby

our research supports sustainability, competitiveness of growers and tailored vegetable quality according to consumer desires.

Regarding consumer preferences in vegetable products, elicitor treatments may be used to obtain vegetables enriched with secondary plant metabolites for sale as fresh market products or used as bioactive additives for functional foods and supplements, thereby promoting higher consumption of these health-promoting substances.

Temperature influences the efficiency of moderate UV-B treatment on the flavonoid profile in kale (*Brassica oleracea* var. *sabellica*)

Abstract

Kale (*Brassica oleracea* var. *sabellica*) has a wide spectrum of structurally different flavonol glycosides. The 71 flavonol glycosides identified, can be non-acylated or acylated with different hydroxycinnamic acids.[1] The aim of this study was to investigate if subsequent doses of moderate UV-B radiation can enhance flavonol glycosides and how temperature influences the efficiency of moderate UV-B radiation.
The cultivar 'Winterbor' was grown to a 4-5 leaf stage in the greenhouse at ambient conditions. Plants were exposed to multiple UV-B doses of 0.5 KJ m^{-2} d^{-1} applied as 5 subsequent treatments (total dose 2.5 KJ m^{-2}) with a 24 h acclimatization in between. The experiments were conducted either at 5°C or at 15°C and ambient PAR.
Generally, the efficiency of subsequent doses of moderate UV-B radiation on flavonol glycoside concentration was higher at 15°C than at 5°C. And also the response of flavonol glycosides was structure-specific as well. E.g. at 15°C the monoacylated quercetin tri-and tetraglycosides were increased after 1.5 KJ m^{-2} up to 2.5 KJ m^{-2} while the corresponding kaempferol glycosides decrease. First results of the molecular investigation (qRT-PCR) showed concomitantly enhanced expression of *flavonol 3'-hydroxylase* at 15 °C after 1.5 KJ m^{-2} up to 2.5 KJ m^{-2}. A consequence of these results could be a new crop management for *Brassica* species.

[1] **Susanne Schmidt**, Michaela Zietz, Monika Schreiner, Sascha Rohn, Lothar W. Kroh, Angelika Krumbein. 2010. Identification of complex, naturally occuring flavonoid glycosides in kale (Brassica oleracea var. sabellica) by high-performance liquid chromatography diode array detection/electrospray ionization multi-stage mass spectrometry. Rapid Communications in Mass Spectrometry. 24. 2009-2022: DOI:10.1002/rcm.4605

Outlook of challenges and opportunities for ongoing UV-B research and for realization possibilities

The use of subsequent doses of moderate UV-B can enhance health promoting substances. This could be a potential tool for the production of functional food on the basis of a new crop management for *Brassica* species or other vegetables.

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