2022 Frutic

14th International Symposium

Valencia (Spain)

29th June - 01st July

2022 Frutic 14th International Symposium

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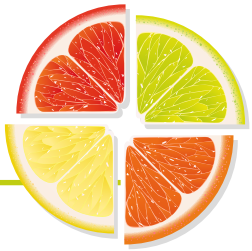

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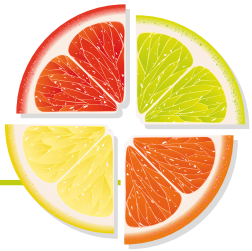
2022 Frutic 14th International Symposium

Date Time	Day 1 June 29 (Wednesday)	Day 2 June 30 (Thursday)	Day 3, July 1 (Friday)	Date Time
09:00		OPENING CEREMONY	KEYNOTE SPEECH	09:00
09:30		KEYNOTE SPEECH		09:30
10:00			ORAL SESSION 5 New products	10:00
10:30		ORAL SESSION 1 Postharvest treatments and technologies 1		10:30
11:00				11:00
11:30		COFEE BREAK	COFEE BREAK	11:30
12:00		ORAL SESSION 2 Postharvest treatments and technologies 1	ORAL SESSION 6 Precise diagnosis	12:00
12:30				12:30
13:00			CLOSING CEREMONY	13:00
13:45		LUNCH BREAK	LUNCH BREAK	13:45
14:00				14:00
14:30		POSTER PRESENTATION		14:30
15:00		ORAL SESSION 3 Precise field operations		15:00
15:30				15:30
16:00				16:00
16:30		COFEE BREAK		16:30
17:00	TECHNICAL MEETINGS	ORAL SESSION 4 Emerging sensors		17:00
17:30				17:30
18:00				18:00
18:30	WELCOME PARTY			18:30
19:00				19:00
19:30				19:30
20:00				20:00
20:30				20:30
21:00		GALA DINNER Balneario Las Arenas		21:00
21:30				21:30
22:00				22:00
22:30				22:30



June 29, Wednesday

17:00 **TECHNICAL MEETINGS** (Zeus)

18:30 **WELCOME RECEPTION AND REGISTRATION** (Exedra terrace)

June 30, Thursday (Zeus)

09:00 **OPENING CEREMONY**

- Ilma Sra. Dña. María Teresa Cháfer Nácher, *Directora General de Política Agrària Comuna (PAC). Conselleria d'Agricultura, Desenvolupament Rural, Emergència Climàtica i Transició Ecològica*
- D. Rodolfo Canet Castelló. *Director del Instituto Valenciano de Investigaciones Agrarias (IVIA)*
- D. Jose Blasco Ivars. *Coordinador del Centro de Agroingeniería del IVIA. Chair of FRUTIC 2022*

09:30 **KEYNOTE 1**

The four quality spheres of an agri-food product
David Bernardo Lopez Lluch. *Área de Economía, Sociología y Política Agraria. Universidad Miguel Hernández (Elche, Alicante)*

10:00 **INDUSTRY TIME**

10:30 **ORAL SESSION 1**
Postharvest treatments and technologies 1

Chair: Guido Rux, *Germany*

10:30 **O1. Dehydrated Apples geographical assessment through Gas Chromatography–Ion Mobility System analysis**
Giuseppe Sammarco, Michele Suman, Chiara Dall'Asta

10:45 **O2. High-Pressure Homogenization applied to Tropical Mixed Fruit Juice: bioactive compounds and physical stability**
Mariah Lima, Inayara Martins, Amauri Rosenthal

11:00 **O3. Effect of 1-MCP treatment on biochemical composition and physical properties of fresh and dried apple**
Ekaterine Burkadze, Gardis von Gersdorff, Barbara Sturm, Manuela Zude-Sasse

11:15 **O4. Porous Media CFD Model of Gas Transfer in Controlled Atmosphere Storage of Pear Fruit**
Ramadan ElGamal, Mulugeta Delele, Pieter Verboven, Bart Nicolai

11:30 **COFFEE BREAK** (Exedra terrace)

12:00 **ORAL SESSION 2**
Postharvest treatments and technologies 2

Chair: Norhashila Hashima, *Malaysia*

12.00 **O5. Potential of Applying Bio-based and Edible Coatings for Horticultural Product**
G. Rux, C. Labude, W.B. Herppich, M. Geyer

12:15 **O6. Evaluation of Two Packing Line Modifications to Reduce Aggressiveness for Stone Fruit**
Coral Ortiz, Antonio Torregrosa, Rubén Mahiques

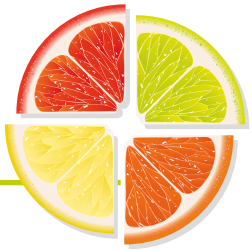
12.30 **O7. Effect of ultrasounds or microwaves treatments to Brassicaceae seeds on the bioactive content during germination**
Lorena Martínez-Zamora, Noelia Castillejo, Marina Cano-Lamadrid, Francisco Artés-Hernández

12:45 **O8. Deep neural network using to automatic detection of hiding bruise in 'Rojo Brillante' persimmon fruit using hyperspectral imaging**
Alejandro Rodríguez-Ortega, Sandra Munera, Salvador Castillo-Gironés, Nuria Aleixos, Sergio Cubero, and José Blasco

13.00 **O9. Non-Invasive Quantification of Phenolic Content in Red and White Wines using a Portable Fluorescence Spectrometer**
Isabel dos Santos, Michelle Niemann, Gurthwin Bosman, Wessel du Toit, Jose Luis Aleixandre-Tudo

13:30 **LUNCH BREAK** (Hera)

14:30 **POSTER SESSION** (Exedra terrace)



15:00 **ORAL SESSION 3**
Precise field operations

Chair: Riccardo Guidetti, *Italy*

15:00 **O10. Nozzle Type and Forward Advance Effect of Bait Treatments Applied with Unmanned Aerial Vehicle (UAV) on Citrus Canopy Deposition**
Patricia Chueca, Alberto Fonte, Roberto Beltrán, Héctor Izquierdo, Cruz Garcerá

15:15 **O11. Air Flow Characterization of Two Air-Assisted Sprayers for Pesticide Application**
Alba Vigo-Morancho, Sergio Hernando, Javier Ignacio Zabalza, María Videgain, Antonio Boné, Mariano Vidal, Francisco Javier García-Ramos

15:30 **O12. Meeting Harvest Goals: Modelling Costs and Benefits of Integrated Mechanized Apple Harvest Platforms**
Noy Saraf, Bracha Gal, Yael Salzer

15:45 **O13. Batch Management According to Quality and Traceability at Field. Innolivar Project**
Sergio Bayano-Tejero, Gregorio Blanco-Roldán, Rafael R. Sola-Guirado, Jesús Gil-Ribes

16:00 **O14. Line 11 C.P.P Innolivar: Integral Harvesting Systems for Table Olives**
Rafael R. Sola-Guirado, Antonio Serrano, Gregorio Blanco-Roldán, Sergio Bayano-Tejero, Jesús Gil-Ribes

16:15 **O15. Estimation of Tomato Leaves Orientation for Early Detection of Diseases Using Artificial Neural Network Models**
Adi Cohen, Avishai Sintov, Avital Bechar

16:30 **O16. Grape Bunch Architecture by Low-Cost 3D Scanner**
Monica Herrero-Huerta, Hugo Tardy, Alberto Morcillo Sanz, Enrique Gonzalez-Gonzalez and Diego Gonzalez-Aguilera

16:45 **O17. End Effector System for Medjool Date Thinning Robot**
Ze'ev Schmilovitch, Dekel Meir, Aharon Hoffman, Rafi Regev, Liad Reshef, Avital Bechar, Yuval Cohen

17:00 **O18. Development of a fertilization dosing tool for irrigation heads**
M. Soler-Méndez, D. Parras-Burgos, D.S. Intrigliolo, J.M. Molina-Martínez

17:00 **COFFEE BREAK** (Exedra terrace)

17:30 **ORAL SESSION 4**
Emerging sensors

Chair: Dolores Pérez Marín, *Spain*

17:45 **O19. Automatic Botrytis detection in grape bunches**
Mariano F. Todeschini, Jose María Bengochea-Guevara, Hector Montes, Dionisio Andujar, Angela Ribeiro

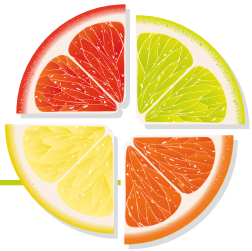
18:00 **O20. Downy mildew detection and localization using deep learning in digital viticulture**
Inés Hernández, Salvador Gutiérrez, Ignacio Barrio, Rubén Iñiguez, Javier Tardáguila

18:15 **O21. In Field Application of Near Infrared Spectroscopy for Monitoring the Quality and Safety of Intact Spinach Plants**
Miguel Vega-Castellote, María Teresa Sánchez, Irina Torres, Dolores Pérez-Marín

18:30 **O22. Near Infrared Spectroscopy for the On-Line Detection of Bitter Almonds in commercial Batches along the Food Supply Chain**
Irina Torres-Rodríguez, María-Teresa Sánchez, Miguel Vega-Castellote, José-Antonio Entrenas, Ana Garrido-Varo, Dolores Pérez-Marín

18:45 **O23. Evaluation of 'Fino' Lemon Cultivar Quality at Different Maturation Stages Using Visible and Near-Infrared Spectroscopy**
Vicente Serna-Escolano, Pedro J. Zapata, Alicia Dobón-Suárez Sandra Munera, Sergio Cubero, Jose Blasco

20:30 **GALA DINNER**
Gala dinner will take place in
Hotel Balneario Las Arenas 5* (at Zeus room)
Address: Eugènia Viñes, 22, 24, 46011 Valencia
Time: 20.30h
*All attendance should bring the dinner ticket with you.



July 1, Friday (Zeus)

09:00 **KEYNOTE 2**

Emerging nonthermal processing technologies for tropical fruit products and ingredients
Amauri Rosenthal. *Embrapa Food Technology. Rio de Janeiro, Brazil*

09:30 **INDUSTRY TIME**

10:00 **ORAL SESSION 5**
New products

Chair: Victor Rodov, *Israel*

10:00 **O24. Spatial and Temporal Changes in Quality Attributes and Plant Growth Regulators during Climacteric Mango Ripening**
Ciara O'Brien, Natalia Falagán, Sofia Kourmpetli, Leon A. Terry, M. Carmen Alamar

10:15 **O25. Making Pomegranate Consumption Easy: A Novel Consumer-Friendly Ready-to-Eat Product**
Yakov Vinokur, Ron Porat, Batya Horev, Victor Rodov

10:30 **O26. Postharvest Characteristics of Goji Berry *(Lycium barbarum L.)* Fruits**
Danial Fatchurrahman, Maria Luisa Amodio, Maria Lucia De Chiara, Giancarlo Colelli

10:45 **O27. National Rootstock Evaluation Program for Citrus in Australia**
Tahir Khurshid

11:00 **COFFEE BREAK** (Exedra terrace)

11:30 **ORAL SESSION 6**
Precise diagnosis

Chair: Tahir Khurshid, *Australia*

11:30 **O28. A Method to Build Citrus Cross-Pollination Risk Maps**
Enrique Moltó, Carmen Orts, José Pardoo

11:45 **O29. PlanetScope Vegetation Indices to Estimate UAV and LiDAR-derived Canopy Parameters in a Super-Intensive Almond Orchard**
Leire Sandonís-Pozo, José M. Plata-Moreno, Jordi Llorens, Àlex Escolà, Miquel Pascual Roca, José A. Martínez-Casasnovas

12:00 **O30. Finite element simulation of drop impact on papaya**
Nurazwin Zulkifli, Norhashila Hashim, Hazreen Haizi Harith, Mohamad Firdza Mohamad Shukery Daniel I. Onwude

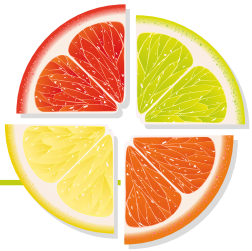
12:15 **O31. Feature Extraction Methods for Intelligent Diagnosis and Classification of Plant Leaf Diseases**
Seyed Mohamad Javidan, Ahmad Banakar, Keyvan Asefpour Vakilian, Yiannis Ampatzidis

12:30 **O32. Are microtensiometers an alternative to pressure chamber determinations of plant water status? A comparative analysis in a potted olive tree**
Daniela Vanella, Mauro Vanella, Juan Gabriel Pérez-Pérez, Cesar Azorin-Molina, Diego S. Intrigliolo, Juan Miguel Ramírez-Cuesta

12:45 **O33. Stand-alone LED sensors for future field monitoring of grape (*Vitis vinifera L.*) ripeness**
Alessio Tugnolo, Valentina Giovenzana, Roberto Beghi, Alessia Pampuri, Andrea Casson, Riccardo Guidetti, and i-GRAPE Consortium

13:00 **CLOSING CEREMONY**
Rodolfo Canet, *Director del Instituto Valenciano de Investigaciones Agrarias*

13:30 **LUNCH BREAK** (Hera)



LIST OF POSTERS

P01. **Fox Project Main results**
Leonor Pascual

P02. **Non-destructive Evaluation of Quality, Cultivar and Origin of Lemons using Visible and Near-Infrared Spectroscopy**
Sandra Munera, Vicente Serna-Escolano, Salvador Castillo, Pedro J. Zapata, Jose Blasco, Alicia Dobón- Suárez, Sergio Cubero

P03. **Production Prediction Based on a Multispectral Camera Installed in A Drone and an Autonomous Guided Vehicle in an Orange Tree Field**
Lorenzo Cervera, Ricard Díaz

P04. **Polyphenol Content Prediction Using vis/NIR Spectroscopy Directly at the Check Point Station Entering the Winery**
Roberto Beghi, Alessio Tugnolo, Alessia Pampuri, Andrea Casson, Sara Vignati, Martina Zambelli, Riccardo Guidetti, Valentina Giovenzana

P05. **Grape-HAND: a Handheld Optical Prototype for Determining the Quality Parameters of Grapes**
Alessia Pampuri, Valentina Giovenzana, Alessio Tugnolo, Andrea Casson, Sara Vignati, Martina Zambelli, Riccardo Guidetti, Roberto Beghi

P06. **Early sunburn symptoms of sweet cherry fruit**
Pano Dulgerides, Manuela Zude-Sasse

P07. **Optimization and improvement of recovering unharvested fruit: Application of an intelligent mobile robot (FOODCOLLECT)**
Ricardo Díaz, Jordi Cirujeda, Francisco Javier López, Gabriele Kubiliute

P08. **Effects of pre-processing cooling treatments of harvested olives on oil volatilome and quality parameters**
M. Vendrell Calatayud, S. Brizzolara, G. Meoni, L. Tenori, C. Luchinat, P. Tonutti

P09. **Potentiality of Hyperspectral Imaging for Authentication of Rocket Leaves Produced According to Different Water and Fertilization Management Systems**
Mojtaba Nosrati, Hassan Fazayeli, Danial Fatchurrahman, Aysha Saleem, Maria Luisa Amodio, Giancarlo Colelli

P10. **Effect of Microwave Treatment on The Sensorial and Nutritional Quality of Pomegranate Arils (*Punica granatum* L. var. Wonderful) Under Modified Atmosphere Packaging**
Danial Fatchurrahman, Maria Luisa Amodio, Maria Lucia Valeria De Chiara, Giancarlo Colelli

P11. **Nutritional Diagnosis of Citrus Through the Use of Visible and Near-Infrared Hyperspectral Imaging**
Alberto Sanz-Hernández, Isabel Rodríguez-Carretero, Sandra Munera, Sergio Cubero, Alejandro Rodríguez-Ortega, Jose Blasco, Ana Quiñones

P12 **A smart approach to evaluate bergamot essential oil content in the field**
Matteo Anello, Bruno Bernardi, Souraya Benalia, Angelo M. Giuffrè, Giuseppe Zimbalatti, Maurizio Iazzolino, Jose Blasco, Juan Gomez Sanchis

P13. **New Model for the Automatic Detection of Anthracnose in Mango Fruits based on Vis/NIR Hyperspectral Imaging and Discriminant Analysis**
Carlos Velásquez, Flavio Prieto, Nuria Aleixos Borrás, Sergio Cubero, José Blasco

P14. **Mineral Nutrient Composition of Leaves and Fruits of 'Rojo Brillante' and 'Sharon' Persimmon Crop**
Julia Morales, Nariane Q. Vilhena, Isabel Rodrígez-Carretero, Alejandra Salvador, Ana Quiñones

P15. **Detection of Anthracnose in Mango cv 'Keitt' using Hyperspectral Imaging and Artificial Neural Networks**
Carlos Velásquez, Nuria Aleixos Borrás, Sergio Cubero, José Blasco, Flavio Prieto

P16. **Spatial Prediction of Soil Organic Carbon using Sentinel 2A**
Abdelkader Laribi, Acheli Lylia, Belkebir Sabrina, Dehnoun Zahida

P17. **Fluorescence emission level under ultraviolet light of different citrus varieties for decay detection**
Andres Prieto, Gema Ancillo, Lluis Palou, Sandra Munera, Sergio Cubero, Nuria Aleixos, Jose Blasco

P18. **Untargeted metabolomics reveals differential response under water stress on leaves of self-grafted and grafted onto a tolerant rootstock pepper plants**
Yaiza Gara Padilla, Ramón Gisbert-Mullor, Begona Miras-Moreno, Luigi Lucini, Salvador López-Galarza, Ángeles Calatayud

P19. **The science behind lettuce micro and baby leafs: the food of the 21st century**
Eva Martínez-Ispizua, Mary-Rus Martínez-Cuenca, José Ignacio Marsal, Ángeles Calatayud

P20. **Antioxidant capacity, total phenols, organic acids, and sugars of breba, figs and leaves of *Ficus carica* (L.) cv Colar**
Candela Teruel-Andreu, David López-Lluch, Esther Sendra, Francisca Hernández, Marina Cano-Lamadrid

P21. **Use of vacuum impregnation as a technology to reduce soaking time and to increase iron content in pulses**
Mila Arnal, Marta Gallego, Leticia Mora, Pau Talens

P22. **Effect of Harvista® application on quality of cold stored 'Rojo Brillante' persimmon**
Nariane Q. Vilhena, Lourdes Cervera-Chiner, Rebeca Gil, Pilar Navarro, Alejandra Salvador

P23. **Effect of deastringency treatments with ethanol and CO_2 on quality of cold stored 'Giombo' persimmon**
Nariane Quaresma Vilhena, Magda Andréia Tessmer, Ricardo Alfredo Kluge, Alejandra Salvador

P24. **Effect of rootstock on the Bioactive Compounds of mandarins**
Pilar Legua, Francisca Hernández, María Ángeles Forner-Giner

POSTHARVEST TREATMENTS AND TECHNOLOGIES

O1. DEHYDRATED APPLES GEOGRAPHICAL ASSESSMENT THROUGH GAS CHROMATOGRAPHY–ION MOBILITY SYSTEM ANALYSIS

Giuseppe Sammarco[ab], Michele Suman[ac]*, Chiara Dall'Asta[b]

[a] Analytical Food Science, Barilla G. e R. Fratelli S.p.A., Parma, Italy
[b] Department of Food and Drug, University of Parma, Parma, Italy
[c] Department for Sustainable Food Process, Catholic University Sacred Heart, Piacenza, Italy
* Corresponding author. Email: michele.suman@barilla.com

Abstract: The geographical origin of apples and apple-based products is nowadays a valuable aspect for high-quality food characterization. Gas Chromatography-Ion Mobility System (GC-IMS) could play a key role as a fast and direct technique for fingerprinting the volatile profile of samples. This study aims to assess the provenience of Italian dehydrated apples via GC-IMS analysis, merged with multivariate statistic approaches. N=71 samples with different moisture rates, varieties, presence/absence of peel, and harvesting years, were analysed in duplicate through FlavourSpec® instrument, according to a Design of Experiment (DoE). Data elaboration was achieved with multivariate statistic models, both unsupervised as Principal Component Analysis (PCA), and supervised as Partial Least Squares – Discriminant Analysis (PLS-DA) and Orthogonal PLS-DA (OPLS-DA). PCA outcomes highlighted a partial clusterisation, and a low explained variance (ca. 30 %), due to the number of samples and the DoE factors. PLS-DA and OPLS-DA approach produced a sharper separation, since they are more efficient than the PCA for dimension reduction, thanks to the supervised nature of its algorithm. OPLS-DA reduces systematic variance unrelated to the sample classes, by removing info from the block of the independent variables to the dependent (or dummy) variables block. This analysis returned interesting values of cumulative R2X (0.805), R2Y (0.765), and Q2 (0.560), respectively about the model fitting to the original data (R2X and R2Y), and the predictive ability of the model (Q2). The goodness of the OPLS-DA model is also confirmed by permutation and cross-validation ANOVA tests. The Misclassification Table, using a prediction set (n=19), provides an accuracy of 94.74 %. The reproducibility and the sensitivity of this analytical strategy, as well as the limited, or even inexistent, sample preparation, and the direct analysis make this method a potential solution for food authenticity studies.

Keywords: Dehydrated apples, Geographical origin, GC-IMS, Multivariate Statistical Analysis, OPLS-DA

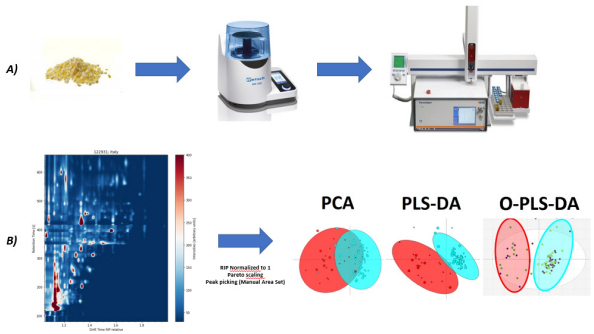


Fig. A) limited and fast sample preparation, the dehydrated apple cubes are minced before the direct analysis. B) Raw spectra obtained undergo the Reactant Ion Peak normalization to 1 and Pareto scaling. Afterward, all the peaks are picked and their relative intensities are exploited for multivariate statistical studies.

O2. HIGH-PRESSURE HOMOGENIZATION APPLIED TO TROPICAL MIXED FRUIT JUICE :BIOACTIVE COMPOUNDS AN DPHYSICAL STABILITY

Mariah Lima[ab], Inayara Martins[a], Amauri Rosenthal[ab]*

[a] Embrapa Agroindústria de Alimentos, Rio de Janeiro, Brazil
[b] Universidade Federal Rural do Rio de Janeiro, Postgraduate Program in Food Science and Technology, Rio de Janeiro, Brazil
* Corresponding author. Email: amauri.rosenthal@embrapa.br

Abstract: High pressure homogenization (HPH) is a non-thermal technology that has been widely studied as a partial or total substitute for thermal food processing. HPH is able of inactivating enzymes and microorganisms that are responsible for food spoilage, as well as preserving sensory and nutritional characteristics, ensuring quality food production.

This study aimed to evaluate the effects of high-pressure homogenization on bioactive compounds, antioxidant capacity and on the physicochemical, physical, and rheological properties of a mixed tropical fruit juice, composed by Cashew, Acerola and Melon. The work was carried out at Embrapa Agroindústria de Alimentos (Rio de Janeiro, RJ, Brazil). The juice was homogenized at pressure levels of 50 MPa and 100 MPa and then compared to the product subjected to pasteurization at 90 ° C / 1 minute, to the juice processed at high hydrostatic pressure at 500 MPa for 10 min. and to juice without treatment. Physicochemical (pH, acidity, soluble solids), total phenolic content, vitamin C, antioxidant capacity and physical stability (particle size distribution, optical microscopy, pulp sedimentation and instrumental color). The juice was kept refrigerated at 4 ° C for a period of 42 days, being the analyzes performed at 0, 14, 28 and 42 days.

There was no significant negative effect on pH, phenolic content and antioxidant capacity compared to the control sample, but HPH had negative effect on vitamin C. HPH significantly affected physical stability, causing reduction in particle size, sedimentation stability. and color maintenance in relation to the control. The results obtained in the rheological analysis showed that the juices fit the Herschel-Bulkley model and there was a reduction in juice viscosity with increasing shear stress, as expected.

The study indicates that HPH could be a promising technology for improving the quality of the tropical fruit juice along the shelf-life, but further research is necessary mainly regarding microbiological and sensory aspects

Keywords: non-thermal process, cashew, acerola, melon, color.

O3. EFFECT OF 1-MCP TREATMENT ON BIOCHEMICAL COMPOSITION AND PHYSICAL PROPERTIES OF FRESH AND DRIED APPLE

Ekaterine Burkadze[ab], Gardis von Gersdorff[b], Barbara Sturm[bc], Manuela Zude-Sasse[b]*

[a] Agriculture University of Georgia, Tbilisi, Georgia
[b] Leibniz Institute for Agricultural Engineering and Bioeconomy, Potsdam, Germany
[c] Humboldt University of Berlin, Berlin, Germany
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Abstract: Increasing shelf life of fresh and processed fruit product and decrease of food waste is crucial for food security and sustainability of agricultural production. The aim of this work was to study the effect of different storage conditions on fresh and dried apples (*Malus* x *domestica* Borkh.) considering the two cultivars Golden Delicious and Pinova from the Shida Kartli region of Georgia.

Apples were harvested in pre-mature and mature stages and subjected to 1-methylocyclopropene (1-MCP) for 24 h before storage, while control fruit without treatment were directly stored at 2°C, relative humidity 90 % and 2 % CO_2 (one-sided controlled atmosphere). Hold periods of fruit groups were 2 and 4 months. Quality of fresh and stored apples was measured capturing fruit flesh firmness measured by standard pressure gauge with 7/16" diameter plungers, soluble solids content (SSC) with refractometer, starch conversion was tested with an iodine solution, sugars with HPLC, total polyphenols and hydroxymethylfurfural (HMF) after extraction photometrically.

Most pronouncedly, the crop's firmness of fruits stored for two and four months decreased. However, 1-MCP treatment reduced the fruit softening. While such an effect is well known for apple, the impact thereof along the supply chain and, particularly, in the production of dried chips had not been approached thus far. Apples of both cultivars, two stages of maturity, with and without 1-MCP treatment were sliced (3 mm) and convectively dried (60°C). For dried samples, the same parameters as for fresh apples were measured and, additionally, dried apple slices were analysed considering osmotic potential and CIELAB colour. Storage under 1-MCP and control as well as all storage durations showed no difference in HMF content in dried samples, whereas only non-consistent effects of sugar contents were found. CIELAB L*, a*, and b* co-ordinates were evaluated, and no significant differences were detected between the groups of dried apple slices.

The study revealed that 1-MCP treatment does not add value to quality characteristics of dried apple chips, considering SSC, sugars, total phenols, unless supports maintaining firmness of matured fruits especially after long periods of storage. Further studies will evaluate the impact of harvest maturity and the assessment of dried apple products by means of low-cost multiwavelength analysis.

Keywords: Apple cultivars, Pinova, Golden Delicious, 1-MCP, Chips

O4. POROUS MEDIA CFD MODEL OF GAS TRANSFER IN CONTROLLED ATMOSPHERE STORAGE OF PEAR FRUIT

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Abstract: In low temperature controlled atmosphere (CA) storage rooms for pome fruit, O_2 and CO_2 concentrations are controlled to minimize the respiration of the fruit and prolong their storage life. The objective of this study was to develop an efficient computational fluid dynamics (CFD) model of transport of respiratory gases (O_2 and CO_2) of pear fruit in CA storage using a porous medium approach. The developed gas exchange model of fruit simulates the gas exchange dynamics of fruit with surrounding air. The porous medium model incorporates three compartments: the surrounding air in the bulk of fruits in bins or boxes, and the fruit with their intercellular space and the cellular compartments. The model calculates air circulation and convective transfer of gasses to the fruit and permeation through the fruit peel, while inside the fruit gasses are consumed or produced due to fruit respiration kinetics in the cells and transported through intercellular spaces. The dynamic response of the gas concentrations inside the CA storage system was predicted as a consequence of fruit respiration and air circulation under different CA storage conditions. Comsol Multiphysics software was used to implement the developed model in a storage container with fruit boxes modelled as a porous medium which avoids to model the complex geometry of fruit shapes stacked inside the boxes.

The model prediction was validated using measured air velocity and gas concentration profiles under different CA storage conditions (ranged from 0.22 to 2.97 kPa O_2 and from 0.4 to 0.75 kPa CO_2). The model results were also compared to a detailed model with explicit fruit shapes that was presented earlier. The overall average relative error of the predicted O_2 and CO_2 distribution in the surrounding free air region was 1.49% and 1.78%, respectively. The predicated average RQ values in the surrounding free air region ranged from 1.03 to 2.23 compared with the measured values of 0.82 to 4.46 under selected storage conditions. The model accuracy in predicting the respiratory gases concentration was robust and comparable with the explicit fruit shape model. The porous media model therefore is suitable for upscaling the simulation to large cool rooms loaded with hundreds of tons of fruit.

Keywords: CFD models, CA storage, pear fruit, porous medium, respiratory gases.

O5. POTENTIAL OF APPLYING BIO-BASED AND EDIBLE COATINGS FOR HORTICULTURAL PRODUCTS

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Abstract: Plastic packaging for fresh horticultural produce has many advantages but generates packaging waste and ecological alternatives are required. Edible coatings on the product surface can retard many processes related to loss of quality, product degradation and shortened shelf life. Lipid coatings are favourites in application on fresh fruits and vegetables, due to their hydrophobic properties. However, EU regulations currently permit the application of coatings only for horticultural products with inedible peels, although many other countries already classified several coatings as consumer safe. Essential, comprehensive and meaningful information on the optimal application of edible coatings on horticultural products with inedible peels are still lacking. In addition, it is currently unclear whether the consumer will accept them. Therefore, the study considered possible areas of application of edible coatings on fresh fruit and vegetables with edible peels and evaluates the consumers' acceptance of and their opinion on the application. This work investigates also the effect of a lipid-based coating on quality and shelf life of fresh cucumbers. The consumer survey showed a positive attitude towards coating as an alternative to packaging and highlighted important requirements for them. The investigated coating was able to drastically reduce water loss and increase shelf life of cucumbers.

Keywords: marked, shelf life, perishables, mass loss, consumer survey.

O6. EVALUATION OF TWO PACKING LINE MODIFICATIONS TO REDUCE AGGRESSIVENESS FOR STONE FRUIT

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Abstract: Fruit damage produced during the postharvest handling operation can cause decisive fruit losses. In certain areas of Valencia region (Spain) during the non-citrus season, packing lines designed to handle citrus fruits are used to process stone fruits. In these cases, fruit losses are considerable since stone fruits are very sensitive and delicate compared to citrus fruits.

In a previous study, a model citrus packing line used to process stone fruit was evaluated. The main aggressive transfer points were identified and quantified with an instrumented sphere: manual dumping and conveyor belt to the singulator. Several proposals were indicated to reduce aggressiveness during handling: automated dumping careful with the fruit and singulator structures protected by shock absorbing materials. Besides, the reduction of the dropping height and the use of deceleration brushes.

The objective of the present study was to measure the effect of the modifications carried out according to the proposals. The automatic dropping did not significantly decrease the impact value but the maximum impact was considerably reduced. Related to the entrance to the singulator, the modified design, changing aggressive structures and protecting with shock absorbing materials, significantly decreased the impact values. Diminution of dropping heights and implementation of shock absorbing materials could facilitate the use of citrus packing lines for stone fruit handling. However, several modifications need to be developed to reduce fruit losses.

Keywords: stone fruit, fruit packing line, aggressiveness, transfer point, damage

O7. EFFECT OF ULTRASOUNDS OR MICROWAVES TREATMENTS TO *BRASSICACEAE* SEEDS ON THE BIOACTIVE CONTENT DURING GERMINATION

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Abstract: Horticultural products in their early development stages are very rich in phytonutrients and fibers, whose intake is necessary and beneficial for human health. Cruciferous sprouts are very suitable in this regard. The objective was to study the effect of an ultrasounds (US) and microwaves (MW) treatment to *Brassicaceae* seeds on the bioactive content, and the remaining effect in the sprouted seeds. The selected seeds were radish (*Raphanus sativus*), arugula (*Eruca vesicaria*), white mustard (*Sinapis alba*) and tatsoi (*Brassica rapa*). An US treatment of 40 kHz for 20 min or a MW treatment of 300 W for 75 s were applied 24 h before sowing, while no treatment was used as a control (CTRL). Afterwards, seeds were germinated for 7 days at 20ºC and 90% relative humidity in darkness. Sprouts were harvested, frozen and freeze-dried until the analysis of the bioactive compounds. Total polyphenol content and total antioxidant capacity (TAC) were determined. The results showed that US treatment increased by ~15 % the biosynthesis of phenolic compounds 2 h after the treatment, and thus, their TAC in the seeds, whereas the MW treatment showed no clear differences with CTRL. Moreover, this effect of the US treatment was also observed in the sprouts after 7 germination days, which was increased by ~12-15 % regarding CTRL, especially in radish, arugula and mustard sprouts. In conclusion, an abiotic stress with US on seeds may be an interesting tool to improve the bioactive compounds content in young sprouts, although the intrinsic mechanisms involved need to be further investigated.

Keywords: Brassica, crucifers, phytochemicals, antioxidants, phenols, germination.

O8. DEEP NEURAL NETWORK USING TO AUTOMATIC DETECTION OF HIDING BRUISE IN 'ROJO BRILLANTE' PERSIMMON FRUIT USING HYPERSPECTRAL IMAGING

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Abstract: Persimmon is a fruit of high social and economic importance for the producer areas in Spain, but it is delicate and can suffer some damage during post-harvest handling. The principal cause of flesh browning in 'Rojo Brillante' persimmon fruit is mechanical damage. Early detection is necessary because this alteration is often only seen when the final consumer peels the fruit, so it goes unnoticed during the post-harvest inspection. The application of non-destructive techniques, such as hyperspectral imaging, allows obtained chemical information of the fruit to determine invisible properties or damages. In this work, a deep neural network (DNN) was developed to detect hide bruises artificially induced on hyperspectral imaging.

Six hundred fifty persimmons were selected and artificially damaged with a controlled force. Hyperspectral images (450-1050 nm) of each persimmon were acquired in laboratory conditions. Previously, each bruise was detected and labelled using a supervised image processing algorithm based on principal component analysis. All spectral reflectance of the damage and sound areas were split into two individual databases to train and validate our DNN. The DNN was built using 12 fully connected batch normalisation, and dropout layers to process 60 spectral bands with only two classes (sound and bruised classes). The results showed that the DNN model effectively detected the labelled bruise (Recall 99%). In addition, the DNN model saw damaged regions located on the surrounding border of the labelled bruised, which were "invisible" to the previously used supervised algorithm. The latter indicates the high accuracy of our neural network.

These results showed that the hyperspectral imaging technique and DNN have great potential to detect invisible damage regions in fruit and, therefore, can be used to detect mechanical damage in persimmon packaging lines.

Keywords: mechanical damage; browning; fruit quality; computer vision; deep neural network.

O9. NON-INVASIVE QUANTIFICATION OF PHENOLIC CONTENT IN RED AND WHITE WINES USING A PORTABLE FLUORESCENCE SPECTROMETER

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Abstract: Phenolic compounds are responsible for some of the most important red and white wine quality attributes. Phenolics are involved in the colour and mouthfeel of wines. In red wines, phenolics are extracted during maceration to optimise phenolic extraction and ensure optimal colour and mouthfeel properties. In white wines, the objective is to minimize and control phenolic extraction during early stages of winemaking to ensure that the wine's mouthfeel is not compromised. The suitability of fluorescence spectroscopy to quantify phenolic content from undiluted and untreated samples was assessed (dos Santos et al., 2022). After the identification of the fluorescence parameters that allowed for the accurate quantification of phenolic compounds, a simplified portable fluorescence spectrometer was built making use of single excitation (280 nm) and multiple emission. The fluorescence properties of red wine fermenting samples were measured together with the phenolic content. For white wines, the spectral properties of samples at different times during the pressing operation were obtained. In this case, the total phenol content of the samples was measured. The results showed that it was possible to quantify phenolic content in both red and white wine fermenting and juice samples. In addition, a measuring chamber was constructed allowing for front-face and direct reflection measurements. The chamber can be incorporated in a fermenting tank or in a pipe at the outlet of the press. The nature of fluorescence technology and the set-up of the instrument also allows for direct reflexion ultraviolet measurements. The simplicity of the portable spectrometer and the fact that relies on ultraviolet visible technology provides a valid and cost-effective alternative to other available technologies.

Keywords: fluorescence spectroscopy, unaltered samples, direct measurements, phenolic compounds, chemometrics

PRECISE FIELD OPERATIONS

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O10. NOZZLE TYPE AND FORWARD ADVANCE EFFECT OF BAIT TREATMENTS APPLIED WITH UNMANNED AERIAL VEHICLE (UAV) ON CITRUS CANOPY DEPOSITION

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Abstract: The use of Unmanned Aerial Vehicles (UAV) is foreseen to be an important new technology for spray application of plant protection products (PPP). Their use for bait treatments is considered adequate because they need low volume rates. The aim of this work was to evaluate the deposition on citrus canopy and the soil spray losses of bait treatments applied with UAV at diverse forward speeds and fitted with different nozzle types. The final goal is to know how these factors affect the spray distribution to optimize this application in citrus crop.

A field assay in a commercial citrus orchard (latitude 39°39'17" N, longitude 0°18'33" O; Sagunto, Valencia, Spain) was carried out. The variety was Clemenules planted at 6.50 m x 5.00 m framework and with tree size of 2.08 m height and 3.45 m diameter along the row and 3.66 m across the row.

An UAV (AGR Qifei, model Q10, China) with 10 L capacity and with one working nozzle located in the centre of the UAV system was used. Bait treatments require coarse droplets to attract the target pest. Consequently, two types of nozzles with this characteristic were selected, one air induction nozzle (AI9504EVS) and one streamjet nozzle (SJ7-04-VP). Furthermore, the forward speed was studied at 2 levels, 24 km/h and 12 km/h. The deposition over the canopy and the soil spray losses were measured through the coverage, droplet size and density on filter paper. The penetration in the citrus tree was estimated with the use of water sensitive papers (WSP) at different positions in the canopy.

The results showed that the density of droplets from the air induction nozzle was higher and their size was big enough to attract the target pest. The streamjet nozzle produced droplets too big to be retained on the leaves. In all cases, the penetration of the droplets in the canopy was low. The lower the forward speed, the higher the droplet density. Bait treatments with UAV are possible but it is important to set up the system adequately to improve its efficiency.

Keywords: drone, pesticide application, coverage, drift, droplet density.

O11. AIR FLOW CHARACTERIZATION OF TWO AIR-ASSISTED SPRAYERS FOR PESTICIDE APPLICATION

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Abstract: Air assisted sprayers are widely used for the application of plant protection products in fruit trees and vineyards. However, the interaction between the air generated by the pneumatic system of the sprayer and the has not been studied in depth. In this sense, as a first step methodologies must be developed to characterize the air flow generated by the equipment. The present work studies the characterization of the airflow generated by both a multirow and an axial air-assisted sprayer. For each equipment, air velocity maps were generated in static and dynamic situation, in laboratory conditions and in absence of wind. In static conditions, the air flow rate ($m^3\ h^{-1}$) generated by the sprayers was first quantified according to the ISO 9898: 2000 standard using a hot wire anemometer. Secondly, air velocities were measured at different distances and heights from the air outlets in different air flow rate configurations. In dynamic situation, tests were carried out setting 3 forward speeds, to assess the effect of this parameter on the air generated by the pneumatic system. For the static and dynamic tests, an ultrasound 3D anemometer was used. As results, the variation of the module and direction of the air velocity vector for all configurations was analysed. Final data were statistically analysed in order to study the effect of independent variables (sprayer configuration, height, distance and forward speed) on air velocity. Significant differences on air velocity were observed due to distance, air flow rate and forward speed, for both sprayers.

This information will be relevant in order to properly regulate the equipment and selecting the ideal flow rate that the pneumatic system should provide depending on the planting frame and the crop geometry.

Keywords: pneumatic system, fan, forward speed, vineyard, pesticide.

O12. MEETING HARVEST GOALS: MODELLING COSTS AND BENEFITS OF INTEGRATED MECHANIZED APPLE HARVEST PLATFORMS

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Abstract: One of the most significant challenges apple growers face during the harvest season is meeting tight schedules while coping with human resources shortages. The study aims to provide growers with a means to estimate the productivity and cost of different workforce assignments; traditional ladder-and-bucket picking and mechanized harvest platforms. It is hypothesized that (1) assigning pickers to mechanized picking platforms will improve the average container filling rate, and (2) perceived subjective workload can account for productivity changes over time. Four workforce assignments were compared; (A) 2 traditional ladder pickers. (B) A harvest platform, with conveyors, operated by 5 pickers, driver included. (C) 2 ground pickers (no ladders) picked the low fruit were followed by a platform, with conveyors operated by 3 crew members, driver included. The platform pickers picked high fruit only. (D) Same as C, but a platform with no conveyors. The platform pickers picked high fruit only. Bin filling rate, subjectively perceived workload (NASA-TLX questionnaire), and fruit quality was examined. The study was conducted in November 2020 during the Cripps Pink harvest. All pickers were asked to fill the NASA-TLX questionnaire at the beginning of the day, and three more times, at equal intervals. Bins' filling start and end times were recorded. The bins were marked and transferred to the warehouse for experts' damage review. The shortest bin filling time was measured for workforce condition C. No quality differences were found between conditions. No perceived workload change was observed during the day; however, pickers assigned to the platforms (in B, C, and D) scored higher subjective workload. Finally, an economic model was developed to calculate the expected productivity and labor and machine costs, considering plantation size, fruit load, available workforce, and platforms.

Keywords: apples, harvest platform, work-study,

O13. BATCH MANAGEMENT ACCORDING TO QUALITY AND TRACEABILITY AT FIELD. INNOLIVAR PROJECT

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Abstract: In olive orchards, it is not usual to keep a complete record of operations carried out as well as the variables involved, so there is an incomplete traceability of fruit harvested. Moreover, and more specifically in the table olive orchards, there is the problem of fruit bruising because the mechanical harvesting. The fruit are not sorted at field in different quality batches and are not properly stored until it reaches industry, so the quality of the fruit worsens and traceability is lost when it is massively processed in the industry. Research line 12 of the Innolivar project aims to offer a solution by developing two prototypes that generates fruit batches at field with a proper quality for processing by the respective industries (oil and table) maintaining traceability for the batches during the production cycle. This work will focus on the prototype of Maqtec company which consisting of a processing line on board a modified container with a steering and levelling system for mobility between the plots. The container is deployed at field to receive the harvested fruit batches, cleaning them of leaves and branches and classifying them by artificial vision into two qualities or batches ('suitable' and 'discard') and sending them for the corresponding industries. The 'suitable' quality is transported by means of a food tank with a refrigerated sodium hydroxide solution preloaded at industry. The prototype is associated with an application for registering the previous operations to harvesting, as well as the harvesting, classifying, and transporting batches, guaranteeing complete traceability, and providing it to the industry. The tests carried out at field in the 2021 campaign have demonstrated the feasibility of applying this prototype with high cleaning efficiency, high batch classification percentages (~97) and a proper log of traceability.

Keywords: food traceability, quality, classification, table olive groves, post-harvest.

O14. LINE 11 C.P.P INNOLIVAR: INTEGRAL HARVESTING SYSTEMS FOR TABLE OLIVES

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Abstract: In line 11 of the C.P.P Innolivar project, two table olive harvesters have been designed, developed, prototyped and tested, based on side cup shakers. The companies have been Talleres Mata Campos S.L. and Moresil S.L. Both have developed a self-propelled prototype, which has several synchronised systems for knocking down, reception and handling of the tasks involved in a harvesting process in a single harvester operated by a machine operator.

Both prototypes are equipped with a four-wheel drive system, a system with various steering modes and a manual and automatic levelling system that enables them to overcome obstacles and complex situations during harvesting on working farms. In addition, the prototypes have a large number of automatisms, such as crown copying by means of ultrasound sensors or by means of an artificial vision camera, and trunk and ground detection by means of a feeler, which help the driver to make the harvesting process simple and comfortable. A harvest monitor has also been incorporated, which allows the route followed by the machine on the working farm to be recorded and sent to a web server and harvest maps to be generated, allowing the plantation's yield to be known at all times.

In terms of the project's results, the percentages of felling in excess of 85% in table and 95% in oil have been obtained in plantations with inadequate pruning for the harvesters and percentages of fruit interception in excess of 80% in table and 90% in oil. Also, tree damage was acceptable, similar to other mechanised harvesting processes, and fruit damage was minimal and suitable for industrial processing as table olives.

In this line of work, two innovative prototypes of integral harvesting harvesters have been developed, suitable both for harvesting table olives and for harvesting olives for oil, which solve the current problem of labour shortage in the field, as well as making traditional and intensive plantations more technologically advanced and profitable.

Keywords: mechanised harvesting, tracking, yield maps, olive groves, digital agriculture

O15. ESTIMATION OF TOMATO LEAVES ORIENTATION FOR EARLY DETECTION OF DISEASES USING ARTIFICIAL NEURAL NETWORK MODELS

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Abstract: Early detection of diseases in tomato is essential to prevent infection of fruit and other plant parts, spreading of the disease in the plot and to minimize crop losses and reduction of quality. A robotic system equipped with an electric resistance sensor is developed to reach, grasp, and measure the conductivity of a tomato leaf. The electric resistance seems to be a significant indicator regarding the plant's condition in early stages of the disease. In order to grasp a leaf and perform the measurement with a robotic arm, a method for automatically identifying the leaf orientation was developed using data from images of leaves taken by a camera mounted on the robot end effector as input to an Artificial Neural-Network (ANN) model. An experiment was conducted on 30 leaves, and 16,200 leaf images in different orientations and distances were captured and automatically labeled. Each image was processed to extract the leaf from the background, recognize the leaf contour and set 16 points on the leaf contour. The ANN received the 16 points on the contour and produces a spatial vector, normal to the leaf's surface. To determine the leaf orientation, several analyses were conducted using one, two and three images of the same leaf in different poses and the changes in the manipulator orientation to take them. The main results show an average accuracy of 20 degrees between predicted and real orientation of the leaf's surface. In addition, the ANN model results were analyzed to optimize the robotic motion in order to best predict the leaf's orientation and improve the accuracy. Those results are satisfying for the robotic end effector to perform the measurement of the leaf's conductivity.

Keywords: Diseases detection, Tomato, Robot, Artificial Neural-Network, Non-destructive measurement

O16. GRAPE BUNCH ARCHITECTURE BY LOW-COST 3D SCANNERG

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Abstract: In precision viticulture, bunch morphology affects the quality of the grapes, and subsequently the wine. Methodologies to objectively and fast evaluated related traits is a pending task within the food industry context.

In this study, we developed a novel high-throughput phenotyping pipeline based on structure light depth-sensing from point clouds acquired by HP 3D Structured Light Scanner Pro S3 of grapevine bunches under lab conditions. For that, a bunch was scanned to provide not only bunch architecture traits but also individual berry characterization by combining 3D modelling and machine learning algorithms.

The quality of the results provided by a visual inspection gives clear promises to breeders to improve the phenotypic selection in an environmentally and economically way.

Keywords: Precision Viticulture, Point Cloud, Grapevine Phenotyping, Grape Bunch Architecture, Low-cost Scanner.

O17. END EFFECTOR SYSTEM FOR MEDJOOL DATE THINNING ROBOT

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Abstract: In agriculture, in general thinning and pruning typically require intensive manual labour. Yet due to task complexity, there is currently no commercially available thinning or pruning autonomous robot systems. Thinning integrates recognition and motion control. The Medjool-dates hold the major of the premium dates market. The main limitation currently slowing down market expansion is that production is labour intensive, where the most labour-intensive task is thinning. Thinning precision and timeliness are crucial for attaining high quality yield over time. Thinning must be accomplished within a four-week period, three weeks after fruit fertilization. Over thinning may lead to yield loss and even to decay of the whole fruit bunch, under thinning may lead to low quality fruit, straining the data-palm, and may decrease the yield in the following year. All these make the automation of Medjool-date thinning highly desirable. The presented research describes the development of an end effector tool for Madjhoul fruitlet thinning using a robotic system. The design includes mechanical design based of two parallel finger mechanism for bundling the spikelet's and a disk saw mounted above the fingers that can slide forwards and cut the spikelet's after they are bundled. A manual prototype was tested in the orchard with young and mature trees. Yields of fruit clusters thinned using the prototype were comparable to yields of the control. The operational time found to be five time faster than manual procedure. A mechatronic unit with a remote control was developed and mounted and tested on a robotic arm. Since no manipulator was available for field test, a mechanical arm was designed and the apparatus was installed on it for experiments in the orchards. A designated arm robot suitable for field operation is under construction these days and will be experimented in the next season.

Keywords: Automation, manual labour, date growing, date yield.

O18. DEVELOPMENT OF A FERTILIZATION DOSING TOOL FOR IRRIGATION HEADS

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Abstract: Fruit trees nutrition is crucial to obtain the desired levels of fruit quality and production. Achieving a balanced formula for each phenological stage is the objective of any producer. To do this, technicians have different commercial formulations, which must be combined taking into account particularly the compatibility and solubility of the different fertilizers

Once an adequate nutritional formula is available, the application system must be configured. There are different types of fertilizer injection to the irrigation system. Similarly, each system regulates the dosing flow in a different way.

From the combination of the fertilizer recipe and the injection system, the next step is to properly adjust the dosage to the irrigation system. And for this, the user must be well trained to adjust: fertilizer concentrations in the tanks; and injection flows depending on the circulating flow through the irrigation system.

So, there is a need to look for a tool that helps the user to properly dose nutrients. In view of the available technology and the advances of our research group, a powerful tool is proposed that will allow: a) knowing the number of plants and emission flows for each fertirrigation sector; b) the formulations in the mixing tanks, taking into account solubilities and compatibilities; c) propose a dosage per plant or per surface unit; d) automatic adjustment of the dosage of the injection equipment.

Keywords: Proportional dosing, smart fertilization, fertigation, fertilizer recipe, agriculture 4.0.

EMERGING SENSORS

2022 Frutic 14th International Symposium

O19. AUTOMATIC BOTRYTIS DETECTION IN GRAPE BUNCHES

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Abstract: Crop pests are the cause of substantial yield losses every year. That is one of the reasons why early detection and treatment are crucial to prevent diseases from fully developing. To achieve detection and treatment, it is necessary to use sensors and actuators to collect the information from the crop and interact with it. Among the sensors, we can point out the usefulness of cameras to obtain information about the crop through RGB images. On the other hand, Deep Learning algorithms have proven to be an excellent means of extracting useful information by processing RGB images. Among the Deep Learning strategies, we can find models that simultaneously detect and classify objects of interest in the images. One of these models will be the basis of the system that we are developing to control Botrytis on grapes. This paper presents the work carried out to select the best model for being integrated in the detection and treatment system under development. Images were taken of grape bunches, both healthy and affected by Botrytis, the week before harvest in a commercial exploitation (vineyards of Terras Gauda, Pontevedra, Spain). They were collected from a mobile platform with a camera (an EOS 7D, Canon, Tokyo, Japan) connected to a computer by a USB port; the computer acquires images at a rate of 2 frames per second with a resolution of 2584x1938 pixels. The type and aspect of the images obtained are shown in Figure 1. The models initially selected to be tested were those with good performance in the COCO dataset [1]; in particular, the models were different versions of Faster RCNN, EfficientNet, CenterNet, and SSD. These models require images with a much lower resolution, so the original images were divided into 12 sub-images. The dataset consists of 3340 images with a total of 10937 labels split into two classes of examples: 6594 examples of healthy grape bunches and 3860 examples of damaged grape bunches. Initial results show that the best performing model is EfficientNet D0, achieving an accuracy of 88% affected bunch area detection.

Keywords: Botrytis detection, Pest detection, Grape, Vineyards, CNNs, Deep Learning,

Figure 1

Reference: [1] https://cocodataset.org/#home

O20. DOWNY MILDEW DETECTION AND LOCALIZATION USING DEEP LEARNING IN DIGITAL VITICULTURE

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Abstract: Downy mildew (*Plasmopara viticola*) is a key disease in viticulture, which negatively affects the quality and yield of grapevine (*Vitis vinifera* L.). Traditional detection of this disease is usually performed manually by experts in the field, resulting in a subjective and time-consuming assessment, thus a technological, AI-driven solution would bring higher levels of reproducibility and sampling. The aim of this work was to develop a method that allows automated detection and localization of downy mildew in the field. Artificial intelligence and computer vision were used to develop the method. RGB images of the grapevine canopy were taken in 13 different commercial vineyard plots located in northern Spain, with different daylight conditions. The images were divided into sub-images and these sub-images were classified into areas with and without downy mildew. Transfer learning, fine tuning and data augmentation were used to classify the sub-images into the two classes with the help of the pre-trained convolutional neural network (CNN) Xception. In this way, a simple object detection algorithm was created, which allowed in each complete image to highlight the areas of the grapevine canopy that had downy mildew symptoms, taking into account the classification of its sub-images. The CNN achieved 92% accuracy and 0.91 F1 score using a hold-out validation, considering the same plots to train and test the model These results reveal an accurate, automated downy mildew detection approach which, combined with the image reconstruction with the classification of its zones, allows to locate in which zone of the vine canopy there are downy mildew symptoms in a precise, objective and fast way. This method shows promising results in digital viticulture, allowing the automatic detection and localization of downy mildew in the vineyard, and also helping to manage this key grapevine disease and reduce the use of pesticides in precision viticulture.

Keywords: digital viticulture, grapevine, artificial intelligence, machine learning, computer vision

O21. IN FIELD APPLICATION OF NEAR INFRARED SPECTROSCOPY FOR MONITORING THE QUALITY AND SAFETY OF INTACT SPINACH PLANTS

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Abstract: Nowadays there is an increasing need for the horticultural sector to provide information on their products to satisfy quality standards and to guarantee the safety of the products that reach the consumers. This study proposes the use of near infrared spectroscopy (NIRS) as a fast, non-destructive, multiparameter technology for the quality and safety assessment of the spinach plants during their growing in the field and at harvest. First, a viability study was carried out for the quantitative prediction of the quality and safety parameters –the soluble solids content (%) and the nitrate content (mg kg^{-1}), respectively– using spinach plants analysed in the laboratory during the 2019 season, using the MicroNIR™ Pro 1700 (908–1676 nm). Given the results obtained in the aforementioned study (R^2_{cv} = 0.66 and SECV = 0.93 % for the soluble solids content and R^2_{cv} = 0.40 and SECV = 812 mg kg^{-1} for nitrate content), an application for the routine analysis of spinach plants in the field was carried out with plants belonging to different seasons (2020, 2021 and 2022) and using a new generation spectrophotometer, ideally suited for the *in situ* analysis, the MicroNIR™ Onsite-W (908–1676 nm). The prediction models were carried out using partial least squares (PLS) regression. The results obtained (R^2_p = 0.87 and SEP = 1.06 % for the soluble solids content and R^2_p = 0.39 and SEP = 640 mg kg^{-1} for nitrate content) confirm that NIRS uses in routine for crop monitoring would enable to support the decision-making regarding the selection of the optimum harvest time and the fertilization requirements.

Keywords: Spinach plants, portable spectrophotometer, routine application, food quality and safety, *in situ* analysis.

O22. NEAR INFRARED SPECTROSCOPY FOR THE ON-LINE DETECTION OF BITTER ALMONDS IN COMMERCIAL BATCHES ALONG THE FOOD SUPPLY CHAIN

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Abstract: One of the most common frauds to which the almond industry faces is the presence of bitter almonds in commercial batches. This makes necessary for the almond processing industry to have available fast, low-cost, non-destructive and reliable analytical methodologies able to be implemented on routine operations to detect the presence of bitter almond kernels in sweet almond batches, assuring the integrity along the food supply chain. Near Infrared Spectroscopy (NIRS) has been proved to have a great potential for the *in situ* and instantaneous assessment of food and for frauds' detection. Thus, the aim of this work was to evaluate the use of NIRS technology to detect online batches of sweet almonds adulterated with different percentages (5 to 20%) of bitter almonds in the processing industries. For this purpose, sweet, bitter and mixtures of almond batches were analysed using a Fourier Transform (FT)-NIR multichannel spectrophotometer suitable for the online analysis, the Matrix-F (Bruker Optics, Germany), which works in reflectance mode in the spectral range 834.20–2502.40 nm. Partial least squares discriminant analysis (PLS-DA) models were developed to classify intact almonds according to their bitterness, obtaining models that correctly classified the 100% of the sweet and bitter almond samples in cross validation. Furthermore, conformity tests were also developed to identify non-compliant or adulterated product batches during the industrial processing, which enabled to identify between the 57% - 100% of the non-compliant product. The results confirm the feasibility of using NIRS as a suitable way of carrying out an online screening of the product to detect those adulterated batches, ensuring to the industry the absence of bitter almonds in the sweet almond batches in the industrial processing.

Keywords: Almond batches, online NIR analysis, classification models, conformity test.

O23. EVALUATION OF 'FINO' LEMON CULTIVAR QUALITY AT DIFFERENT MATURATION STAGES USING VISIBLE AND NEAR-INFRARED SPECTROSCOPY

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Abstract: Lemon fruit is highly appreciated worldwide by consumers. Therefore, there are established essential quality standards for commercialisation. It is known that physicochemical parameters of lemon fruits decrease during the maturation stage in the tree. Hence, those parameters that determine fruit quality are higher in young lemons than those harvested at the end of the season. Postharvest lemon fruit strategies to preserve the quality are based mainly on controlling room temperature and fungicides. However, the maturity stage of lemon fruit at harvest strongly determines the shelf life, so the interest in applying non-destructive techniques for quality control in postharvest is increasing. This experiment consisted of using spectroscopy techniques to evaluate main quality parameters of 'Fino' cultivar harvested in three crucial stages of the maturation cycle. Three detectors were used sensitive to 400-750 nm (VIS), 600-1000 nm (VIS/NIR) and 950-1700 nm (NIR), respectively. Sets of each harvest were composed of 70 lemon fruits. Therefore, a total of 210 fruits were analysed. Partial least squares regression (PLS-R) models were calibrated to predict total soluble solids (TSS) in the juice of each sample as an indicator of the internal quality. The three detectors had similar results predicting TSS, with R^2_P = 0.79 and $RMSE_P$ = 0.31 using the VIS detector, R^2_P = 0.78 and $RMSE_P$ = 0.31 using the VIS/NIR detector, and R^2_P = 0.82 and $RMSE_P$ = 0.28 using the NIR detector. Furthermore, the VIS and VIS/NIR detectors classified correctly 100 % of the samples while the NIR detector only 95 %. These results showed that spectroscopy techniques based on VIS or VIS/NIR detectors could predict TSS content correctly in lemon fruits.

Keywords: Lemon fruit, total soluble solids, spectroscopy, quality.

NEW PRODUCTS

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O24. SPATIAL AND TEMPORAL CHANGES IN QUALITY ATTRIBUTES AND PLANT GROWTH REGULATORS DURING CLIMACTERIC MANGO RIPENING

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Abstract: The transport time required to supply non-tropical markets with fresh mango (*Mangifera indica*) calls for a longer postharvest life, commonly achieved through cold storage. According to FAO, the UK alone imported approximately 55,000 tonnes of mango in 2020, with numbers growing in recent years. While the physiology through ripening has been previously described, the biochemical regulation of these changes and the effect of cold storage remain largely unknown. Quantifying the spatial and temporal distributions of plant growth regulators (PGRs) can putatively identify the drivers of ripening at the postharvest stage. Relevant PGRs include abscisic acid (ABA, typically thought to induce ethylene production), cytokinins (involved in processes such as sugar metabolism), and gibberellins (which can delay ripening). In this study, two mango cultivars were 'cold stored' at 9°C and high (>85%) relative humidity (RH) for 21 days, to mimic transit conditions, before being transferred to 20°C and high RH to ripen. 'Control' fruit was placed immediately at 20°C and high RH, without cold storage. This work relates mango physiology and biochemistry, including the PGRs regulating changes in commercially important physiological traits, such as firmness and colour, both within a single fruit (spatially) and through storage (temporally). Firmness loss and colour development were faster in the pulp closer to the stone than the skin of the fruit of both 'Keitt' and 'Kent' cultivars, but with differences in spatial variation. Distribution and changes PGRs concentration are described, and their relationships with physiological changes further discussed. Understanding the causes of these changes can be used to improve postharvest treatments for imported mango, increasing supply chain resilience by reducing loss and waste.

Keywords: Postharvest, Plant Hormones, Shelf Life, Cold Storage, Ripening.

O25. MAKING POMEGRANATE CONSUMPTION EASY: A NOVEL CONSUMER-FRIENDLY READY-TO-EAT PRODUCT

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Abstract: Pomegranate is known as healthy super-fruit but its consumption is complicated by laborious hand-staining manual peeling procedure. The existing alternatives to manual peeling (e.g. industrial juices, separated arils, home- or kiosk juicing) have their own weaknesses.

The objective of our work has been development of consumer-friendly pomegranate consumption method. A novel patent-pending product allows easy and hygienic pomegranate consumption as instantly squeezed juice without additional equipment needed. The product comprises a proprietarily precut pomegranate fruit and a multifunction compostable flexible package that facilitates storage, marketing, processing and consumption of the product, as well as sustainable disposal of the processed debris. The development includes also a set of instruments for manual product preparation, and a prototype model of processing machinery.

In this study, the storage performance of the new product was compared with separated pomegranate arils. The optimally packaged new product could be stored for at least 3 weeks under shelf life conditions (8°C) outperforming the separated arils by lifespan, sensory and nutritional quality and 3-log lower microbial load. In a consumer survey performed by an independent company, 72% out of 120 respondents confirmed their willingness to purchase such product when available. The development is ready for commercialization.

Keywords: *Punica granatum*, fresh-cut, freshly squeezed juice, modified atmosphere, compostable package.

O26. POSTHARVEST CHARACTERISTICS OF GOJI BERRY (*LYCIUM BARBARUM* L.) FRUITS

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Abstract: In spite of the well-known nutritional content of goji berry, its use as fresh fruit is still limited because of the lack of information on its postharvest characteristics. Different experiments were carried out in order to study their postharvest behavior based on fruit metabolic indicators (i.e. respiration and ethylene production), the effect of storage temperature, and the possible sensitivity to chilling injury and exogenous ethylene. Fruit were stored at different temperatures (0, 5, and 7 °C) and, in a separate experiment, exposed to different ethylene concentrations (0.5 and 1.3 uL/L). Quality attributes, including Soluble Solid Content (SSC), pH, Total Acidity (TA), texture, color, electrolytic leakage, Vitamin C, total phenol, anthocyanin, and incidence of chilling and decay, were evaluated over the storage time. In addition, fruits from different developmental stages from green to full red, where characterized for dimensions, weight, respiration activity, and ethylene production. The results indicated that goji showed a respiration peak in the early developmental stage, accompanied by a color change and increase of SSC after being stored for 8 days at room temperature. Furthermore, as for storage temperature effects, fruits stored at 0 °C showed a higher incidence and severity of chilling injuries, appearing as a dark spot and pitting; 5 °C was the best storage temperature, minimizing chilling injury while allowing a reasonable shelf-life up to 9 days after harvest, whereas fruit marketability at 7 °C was limited by the higher incidence of decay. Additionally, the study of fruit sensitivity to ethylene showed that goji berry fruit were very sensitive to ethylene even at concentrations as low as 0.5 uL/L which induced firmness loss, yellowing of fruit peduncle, and higher susceptibility to decay particularly at the concentration of 1.3 uL/L. The information obtained from these experiments might be very important in order to improve the distribution of fresh goji berries with a high level of quality.

Keywords: storage temperature, developmental stages, respiration, ethylene production, chilling

O27. NATIONAL ROOTSTOCK EVALUATION PROGRAM FOR CITRUS IN AUSTRALIA

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Abstract: The Australian citrus industry is one of the Australia's largest horticultural industries with commercial production in five states and one territory planted over 28,300 ha. Over 290,000 tonnes of citrus fruit worth of $524.5 million were exported in 2019. Sweet oranges accounted for 68% of the volume and 58% of the value, while mandarins accounted for 30% of the volume and 40% of the value. Australia exported fruit to 48 countries in 2019 with 24 of those countries in Asia.

The development and adoption of high performing rootstocks are fundamental to support the growth and profitability of future citrus orchards and meet consumer expectations. Rootstocks profoundly influence several aspects of citrus production like tree vigour, precocity, productivity, fruit quality, and resistance to abiotic and biotic stresses. There is a need for consistent production and supply of a high-quality fruit with improved external and internal quality suitable for both domestic and export markets.

The current national program is evaluating a range of rootstocks imported from overseas countries and to find the rootstocks which performs better than the locally used rootstocks in Australia. The import of 56 Chinese and Vietnamese rootstocks started in 1992 and since then the program has commercialised 6 rootstocks for the Australian citrus industry. The program is working on the imported Italian rootstocks and on the Californian rootstocks. A range of slat tolerance rootstocks developed by the NSW DPI breeding program has been tested on salty area of Western Australia, and 2 varieties are identified as salt tolerant rootstocks. These varieties will be commercialised in near future. Two varieties are recently identified as dwarfing rootstocks from the Chinese rootstock program and these varieties will also be available to citrus growers in near future.

The national rootstock program is now working in collaboration with USDA, Fort Pierce, and the University of Florida on Huanglongbing (HLB) tolerant rootstocks in Australia for yield and fruit quality. These rootstocks will also be tested in Indonesia in a recently funded project from the Australian government and citrus industry. The identification of HLB tolerant rootstocks will prepare the citrus industry of Australia in case the disease occurred in future.

New South Wales DPI has recently signed an agreement with IVIA, Spain to exchange rootstock material. Under this agreement the Spanish rootstocks will be evaluated in different soil types and climatic conditions in Australia, while the salt tolerant and dwarfing rootstocks will be tested in Spain. The presentation will elaborate on research work being conducted at the research facility at Dareton and around 20 trial sites in 5 states of Australia.

Keywords: Citrus, rootstocks, salinity, dwarfing, Huanglongbing

PRECISE DIAGNOSIS

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O28. A METHOD TO BUILD CITRUS CROSS-POLLINATION RISK MAPS

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Abstract: The Valencian citrus production is intended for the fresh market, so mostly seedless varieties are grown. However, some varieties may induce the formation of seeds in other varieties what is called cross-pollination. This phenomenon is mainly caused by pollinating insects, since wind driven pollination is almost null for most commercial citrus. Consequently, honey and citrus producers may have conflicting interests at citrus flowering time. Therefore, the Regional Government establishes mitigation measures to meet the interests of both industries by limiting the settlement of hives near citrus areas during the flowering season or by regulating the use of plant protection treatments potentially harmful to bees.

The goal of this work is to design tools to manage this issue impartially, using scientific knowledge and ground data on a geostatistical model that estimates the distribution of the risk of cross-pollination in our territory. The model is based on two data sources:

- An official database containing geo-referenced information of more than 215000 orchards and the declaration of the citrus variety grown.
- Studies carried out by the IVIA for more than 25 years, assessing the capacity of each commercial variety to induce seeds in the others, as well as their sensitivity to pollination by other citrus.

The model assumes that the capacity for cross-pollination depends on a) the varieties planted, b) the amount of plants that intervene in the cross-pollination, and c) the distance between the plots that interact.

For each plot planted with a variety sensitive to pollination, all neighboring plots with pollination capacity that are at the maximum distance of bee flight (3 km) are determined. Then, the risk that each of them induces on the sensitive plot is estimated, based on the IVIA's pollination data and applying correction factors for distance and planted surfaces. All the risks induced by the plots neighboring the plot under study are added up. Finally, the risk of a given area is expressed as the sum of the risks of its orchards.

Results are reflected in a risk map of the Valencian Region that is currently used to optimize the location of hives an also for planning the development of the citrus sector taking into account the increase or decrease in pollination risks.

Keywords: Geo-statistics, Google Eath Engine, GIS, Comunitat Valenciana

O29. PLANETSCOPE VEGETATION INDICES TO ESTIMATE UAV AND LIDAR-DERIVED CANOPY PARAMETERS IN A SUPER-INTENSIVE ALMOND ORCHARD

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Abstract: Continuous monitoring of orchard parameters is a key aspect to achieve more sustainable and accurate management actions in super- intensive orchards such as pruning, dose adjustment in application of foliar treatments and pesticides, among other. Despite 3D points derived from LiDAR and UAV photogrammetry are being used to measure canopy architecture, there is still a gap to bridge in the development of software to process this information. The present work tries to be a step forward to estimate maximum height and width of super-intensive fruit tree orchards from PlanetScope multispectral indices, taking chance of the high temporal (diary) and spatial resolution (3x3 m) offered by this constellation. LiDAR and UAV point clouds were acquired in 2021 in a super intensive almond orchard in two decisive moments for orchard management: after mechanical pruning (June) and before harvesting (September). These 3D point clouds were summarized every 0.5 m for the maximum width and the maximum height of the orchard canopy along the rows, and interpolated by means of block kriging to the pixel centroids of the PlanetScope image. A multivariate correlation among the two datasets and the PlanetScope vegetation indices (NDVI and GNDVI) was carried out. NDVI was the index showing the best correlation both, with maximum height ($R = 0.8 – 0.85$) and width ($R = 0.67 – 0.75$), in September, when vegetation was fully developed. In June, after the mechanical pruning, the correlations were poorer because the canopy geometry was artificially adjusted. The results indicate that vegetation indices from PlanetScope images could be useful for monitoring canopy geometry in hedgerow orchards, in particular to decide about pruning intensity.

Keywords: Orchard monitoring, Canopy geometry, NDVI, GNDVI, LiDAR point clouds, UAV photogrammetry

O30. FINITE ELEMENT SIMULATION OF DROP IMPACT ON PAPAYA

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Abstract: Mechanical damage to papaya caused by impact or quasi-static compression is a significant problem for the papaya industry. In this study, the FE modelling was used to predict the mechanical failure in papaya upon drop impact loading. Two dropped orientations, i.e., vertical and horizontal and five dropping heights (0.15 m, 0.25m, 0.5m, 0.75m and 1m), were tested during the simulation. The papaya was modelled into a 3-dimensional model, underwent the free-fall impact onto a rigid surface from the predefined impact heights under standard gravity. The simulations were carried out by the explicit dynamic solver LS-DYNA 14.0. An elastic-plastic model was employed for the solid papaya model. The bruised region was precisely bordered and extracted from the deformed body in the simulation and was exported to CAD software to calculate the deformed length and bruise area. Good correlations were obtained between the simulation and measurement, with the minimum and maximum errors being 3.4% and 19.0% for maximum deformed length, and 2.09% and 26.04 % for bruise area. In conclusion, the FE model developed in this study can serve as a reliable and straightforward prediction method to predict the failure in papayas upon impact loading.

Keywords: Papaya; drop test; finite element modelling

O31. FEATURE EXTRACTION METHODS FOR INTELLIGENT DIAGNOSIS AND CLASSIFICATION OF PLANT LEAF DISEASES SEYED

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Abstract: Plant diseases are serious causes in reducing quality and quantity of productions. Visual evaluation of plants by human observers is time consuming, costly and prone to error. Disease assessment and plant maintenance require new and innovative methods to meet the challenges in the field of agricultural production. In this regard, sensors and imaging techniques have shown great potential in creating new approaches to plant pathology interactions and the diagnoses of plant diseases. Advances in agricultural technology have created opportunities for the diagnosis and non-destructive classification of plant diseases. There are many advances in computer vision that help identify and classify plant diseases automatically. A classifier diagnoses plant as healthy and unhealthy with the given features (color, texture, and shape) as input to automatic diagnosis. Accuracy is the main parameter that every researcher uses to calculate the performance of the model. The accuracy of the classifier depends primarily on the features that are extracted; therefore, feature extraction plays a vital role in identifying a disease. Proper selection of the correct features leads to high diagnostic accuracy. Feature engineering in Machine Learning and Deep Learning are the two main types of feature extraction methods which will be explored in this research.

Keywords: Feature Extraction; Plant Disease; Image Processing; Machine Learning; Deep Learning.

O32. ARE MICROTENSIOMETERS AN ALTERNATIVE TO PRESSURE CHAMBER DETERMINATIONS OF PLANT WATER STATUS? A COMPARATIVE ANALYSIS IN A POTTED OLIVE TREE

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Abstract: Stem water potential (SWP) is considered as the standard indicator for monitoring crop water status (CWS). Generally, SWP measurements are performed with a Pressure Chamber equipment. Despite this is a robust method, the leaves selection uncertainty and its temporally point-based nature are some of its main associated limitations. In the last decade, new microtensiometers have been developed (i.e. FloraPulse, FP) which are installed into the tree trunk providing continuous SWP measurements. The aim of this study was to explore the suitability of SWP measured using Pressure Chamber (SWP_{PC}) and FP (SWP_{FP}) to detect changes in CWS by evaluating the agreement between the measured SWP by both methods. The study was conducted, during the period 17th February – 13th May 2022, in two experiments: (i) a potted olive tree, where a FP sensor was installed to evaluate SWP_{FP} response to canopy wetting, cable's length variation and canopy shadowing; and (ii) an olive orchard for evaluating the SWP_{PC} and SWPFP relationship under field conditions. With the dataset obtained from the potted olive experiment, a multi linear regression analysis among SWP, soil water content (SWC) and weather parameters was carried out. The results of the comparison between the SWP values derived by both methods showed the same pattern, although SWPPC was more sensitive to changes in CWS than SWPFP. Moreover, there was a significant relationship between the SWP measured with both methods, which allows correlating measurements taken on the leaves and on the trunk ($SWP_{FP}=0.53\times SWP_{PC} - 0.19$; $R^2=0.76$). The results of the multi linear regression analysis showed that SWPFP can be accurately determined from SWC, relative humidity, reference evapotranspiration and air temperature data ($R^2=0.64$). In conclusion, FP sensors were able to continuously detect changes in CWS, despite presenting a lower sensitivity than classical SWP_{PC} measurements.

Keywords: crop water status, water potential, sensors, crop water requirements.

O33. STAND-ALONE LED SENSORS FOR FUTURE FIELD MONITORING OF GRAPE (VITIS VINIFERA L.) RIPENESS

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Abstract: In the winemaking industry, the grape maturation control is a complex process that is critical to produce high-quality wines, but currently, maturation control is cumbersome and inefficient. This inefficient control of the maturation is related to a reduced value of the wine. This work aims to develop of a fully integrated stand-alone optical devices for grape quality monitoring directly in field. During the sampling campaign 2019 a prototype of a fully integrated optical device was developed by INL following a "stripe" design in which the spectrometric components were mounted on a long, flexible substrate which can be placed onto or inside the grape bunch. The multiple spectrometers were placed along the stripe enabling simultaneous measurements at different parts of the grape bunch to have more representative information of the entire bunch. 4 optical bands associated to the evolution of the maturation parameters of the grapes such as the development of anthocyanins and sugars, chlorophyll degradation, and decrease of water content were integrated. Four light-emitting diodes (LEDs) in the visible and short wave near-infrared (SW-NIR) range were used for illumination of the grape. Placed close to these, but optically isolated using an opaque barrier, four photodiodes (with an active area of 520 × 520 μm^2) assembled with spectral filters to allow intensity measurements at the desired wavelengths were used. 4 PLS models were developed and validated using an external test set (R^2_{Pred} and RMSEP) for the prediction of the total solids soluble and potential alcohol (R^2_{Pred} about 0.90 and RMSEP of 2.22 and 1.54, respectively). A very promising model was also obtained concerning the prediction of the titratable acidity (R^2_{Pred} of 0.93 and RMSEP of 1.39) while a pH predictive model (using 4 latent variables) was developed showing a lower performance than previous parameters (R^2_{Pred} of 0.76 and RMSEP 0.15) but still with potential for being used with further improvements.

Keywords: IoT, information technology, sensors, optical stand-alone devices, grape maturation monitoring.

POSTERS

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P01. FOX PROJECT MAIN RESULTS

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Abstract: The FOX (food processing in a box) Project, coordinated by the German Institute of Food Technologies (DIL), brings together innovative soft processing technologies so that growers can use their fruit and vegetable surpluses to develop products with greater added value. Its goal is to create shorter, more sustainable supply chains by adapting large- scale processing technologies to small, flexible mobile container units, thereby helping to cut food waste and reduce the need to transport produce to centralised processing facilities. Launched in June 2019, the 4.5 year FOX project is part of the European Commission's Horizon 2020 programme bringing together 25 partners from nine European countries.While other food processing containers already exist, the ones that are being developed by the FOX project are unique in that they focus on mild and innovative food processing technologies like vacuum spiral filters, pulsed electric field (PEF), ultrasound and others. Thus, the processed fruits and vegetables are of better quality as the processes are more gentle compared to standard processes. Four types of unit are now being developed based on different technologies and oriented to different types of products and regions. All the prototypes will be available by 2023, when demonstrations will take place in different regions across Europe, denoted Food Circles. The Food Circles link a specific FOX processing technology with a regional (short) food supply chain. Six European regions have been chosen with important fruit and vegetable production in order to demonstrate the technical, economic and social viability of the FOX approach. These are located in Spain, Czech Republic, Poland, France, Germany and the Netherlands. One of the factors that makes FOX unique is that the Project follows a general approach called the "multi-actor approach", in which end users, such as farmers and consumers, are fully involved during the whole project.

https://www.fox-foodprocessinginabox.eu/

Keywords: short food supply chain, fruits and vegetables mild processing, down-scale processing technologies, sustainable food system

P02. ON-DESTRUCTIVE EVALUATION OF QUALITY, CULTIVAR AND ORIGIN OF LEMONS USING VISIBLE AND NEAR-INFRARED SPECTROSCOPY

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Abstract: Spain is the main producer of lemon in the Mediterranean area. The postharvest industry of this citrus fruit is showing a special interest on the application of new techniques for the automation of the quality control. For this reason, diffuse reflectance spectroscopy, widely used for the non-destructive evaluation of the quality of a great variety of vegetables and fruits, was evaluated in this study to determine their quality and to discriminate the cultivar and geographical origin.

A total of 2,450 lemons representing seven commercial cultivars (Eureka C.S., Eureka S.S., Fino 49, Fino 95, Fino N., Verna M. and Verna N.) and three different geographical origins (Librilla, Lo Vilella and El Pino) were analysed by visible and near-infrared diffuse reflectance spectroscopy. Three detectors were used individually: the first one was sensitive in the range 400 -750 nm (VIS); the second one 600-1000 nm (VIS-NIR) and the third one was sensitive in the range 950-1700 nm (NIR). Partial least squares regression (PLS-R) models were calibrated to predict the internal quality properties measured in the juice such as ºBrix, titratable acidity (TA), citric acid (CA) and total phenolic compounds (TPC) while partial least squares discriminant analysis (PLS-DA) models were calibrated to discriminate cultivar and geographical origin.

As a result, when the PLS-R models were calibrated using all samples of all cultivars, the quality properties better predicted were ºBrix and TA with a R2P and RMSEP of 0.77 - 0.46 and 0.67 – 0.42 using VIS detector, 0.73 - 0.50 and

0.65 – 0.43 using VIS-NIR detector and 0.67 and 0.56 (only ºBrix) using NIR detector. When the properties were predicted

using the samples of each cultivar separately, ºBrix obtained also the highest R2P and RMSEP values in Eureka S.S (0.87-

0.26, 0.82-0.31 and 0.83-0.31 for each detector), Fino 49 (0.65-0.41, 0.70-0.8 and 0.75-0.35 for each detector), Fino 95 (0.81-0.45, 0.76-0.50 and 0.71-0.35 for each detector) and Verna M. (0.76-0.33, 0.73-0.35 and 0.73-0.34 for each detector). TA was predicted with high values only in Fino 49 for the three detectors (0.70-0.42, 0.73-0.40 and 0.69-0.43).

Regarding to discriminant models, the three detectors provided good results in the cultivar discrimination with rates of 100% of correctly classified samples for VIS and VIS-NIR detectors and 90.8% for NIR detector. As for the geographical origin, 99.9%, 99.8% and 92.5% were correctly classified using VIS, VIS-NIR and NIR detector, respectively.

Keywords: Citrus lemon; non-destructive; chemometrics; spectroscopy

P03. PRODUCTION PREDICTION BASED ON A MULTISPECTRAL CAMERA INSTALLED IN A DRONE AND AN AUTONOMOUS GUIDED VEHICLE IN AN ORANGE TREE FIELD

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Abstract: Prediction of fruit production before the picking date is an important activity for fruit producers to help them manage and organize picking, storage, and commercialization strategies. In this study, a drone, and an autonomous guided vehicle (AGV) combined with a multi-spectral camera were used to predict the production in an orange tree field in Valencia, Spain.

The first stage of the procedure was similar in both cases. Images of a group of orange trees in a field were obtained with a multi-spectral camera installed in a drone or in an AGV. Those images were then corrected to obtain the radiance first, then the reflectance and later were orthorectified and geopositioned. From the corrected images, reflectance spectra of the different materials appearing on them were gathered and a classification algorithm was applied to differentiate each pixel on the images.

The second stage differed depending on the vehicle used. For the drone, where the resolution was lower, a model was developed to regress the actual production of each orange tree, measured by field technicians after the picking of the fruit, on the leaf area measured on the images. For the AGV, where the resolution was higher, the regression of the production was made on the detected number of oranges measured in the images corresponding to each orange tree.

Both regression models were lineal with a R^2 of around 0.8, showing a strong relationship between production and the leaf area, for drones, and the detected number of oranges, for the AGV.

Keywords: production estimation, multispectral image, classification algorithm, unmanned vehicles

P04. POLYPHENOL CONTENT PREDICTION USING VIS/NIR SPECTROSCOPY DIRECTLY AT THE CHECK POINT STATION ENTERING THE WINERY

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Abstract: The aim of this work was to investigate the applicability of vis/NIR spectroscopy for rapid assessment of grape of polyphenol content directly at the check point station, entering the winery. A process spectrometer for non-contact analysis at a distance between sensor and sample of 150 mm, in the spectral range 400–1650 nm was used. Acquisitions were carried out on healthy bunches (mechanized collection) of *Vitis Vinifera* L., 'Ancellotta' variety. Sampling consisted of 10 weekly sampling time, in order to cover the maturation period, 9 samples for each sampling date, for a total of 90 samples. In this first experimental trial, optical measurements were performed in lab-scale controlled condition and the samples were manually positioned under the spectrometer.

Partial Least Squares (PLS) regression analysis was applied on grape spectra in order to predict the polyphenol content. The results obtained from PLS models, gave determination coefficients and a root mean squared errors equal to 0.86 and 0.73, and 227 (mg/l) and 315 (mg/l) for calibration and cross validation, respectively. Results demonstrated that the system is capable to provide useful information about wine grape phenolic content and hence the colour using a process device, in a view of a direct in-line application at the check point station for a better management of the vinification process.

Overall, the use of vis/NIR spectroscopy, recognized as a non-destructive optical green technology, promotes sustainable food chain. In fact, applying smart devices would help the wine sector to obtain a supply chain in line with the industry 4.0 approach.

Keywords: Visible-Near Infrared, Spectroscopy, Optical analysis, Chemometrics, Agriculture 4.0

P05. GRAPE-HAND: A HANDHELD OPTICAL PROTOTYPE FOR DETERMINING THE QUALITY PARAMETERS OF GRAPES

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Abstract: Controlling the ripening stage of grapes in the field has become increasingly crucial, both to assure high-quality raw materials and to help winemakers to take decisions. Another important factor to consider is sustainability. Chemical analyses, which are employed in laboratories to evaluate qualitative parameters of grapes, necessitate the use of chemical reagents, as well as a large amount of time and skilled staff. Optical analyses, on the other hand, are a viable option. The bulk of commercially available spectrophotometers are now prohibitively expensive bench devices that cannot be used for in-field measurements. As a result, researchers are concentrating their efforts on ensuring that this type of optical analysis maintains its excellent performance while using simple, portable, and easy-to-use instruments.

Grape-HAND is a low-cost visible/near-infrared prototype that was used to evaluate qualitative characteristics of Vitis vinifera L. grapes *Chardonnay* variety using spectroscopic data and predictive modelling. The optical measurements were made in the field with 12 visible/NIR wavelengths: 450, 500, 550, 570, 600, 610, 650, 680, 730, 760, 810, and 860 nanometres. Sampling included two harvest years; after performing PCA analysis, the qualitative parameters were predicted using a multivariate model created using the real values of the parameters (total soluble solids, titratable acidity, and pH) as determined by the reference laboratory analyses. Partial Least Square regression method was used to create the models, cross-validation was performed with the leave more out technique. Concerning test-set validation, the dataset was randomly divided into a training set (60% of samples), corresponding to the calibration set, and into a test set (40% of the samples). The most efficient model was the one for total soluble solids prediction that gave a R^2 = 0.87 (independent test set validation).

The results revealed that the optical prototype is capable of giving essential data to assist operators in making quick and objective decisions, promoting a sustainable approach and viticulture 4.0. Our research is focused on grape analyses, but this type of analysis and devices can certainly be applied to larger fruit and to other agri-food sectors.

Keywords: grape quality, field measurement, vis/NIR spectroscopy, viticulture 4.0, chemometrics.

P06. EARLY SUNBURN SYMPTOMS OF SWEET CHERRY FRUIT

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Abstract: There is not much knowledge in literature about the types and severity classes of sunburn damages in sweet cherry. Three types of damage may be classified, which are bleaching, softening and browning. While the latter describe more severe symptoms of sunburn, an early symptom may be the bleaching. In the present study, three sweet cherry (*Prunus avium*) cultivars, Drogan's Gelbe, Büttner's späte Knorpel, and Merton Late, were analysed for four weeks, two times a week during fruit development considering the pigment contents and visual appearance of browning. Weather data and stem water potential were recorded in parallel. In the period 4th June until harvest frequently maximum air temperature reached above 30 °C recognized as single hot days, whereas a four-days heat wave was recorded starting 17th June. However, hot days were mostly cloudy. During the heat wave, cherry fruit were either in the end of stone hardening stage (early cultivars) or in the beginning of fruit developmental stage III (late cultivars), with cell enlargement of mesocarp. While fruit softening and browning did not occur, bleaching was visually noticed. The chlorophyll analysis revealed that chlorophyll contents decreased during the heat wave, but recovered within 3 to 7 days. The effect of bleaching appeared in the chlorophyll catabolism, showing enhanced ratio of the chlorophyll degradation product pheophytin_a and the entire chlorophyll pool particularly in fruit grown with South orientation. Since chlorophyll degradation can be measured non-destructively, this early symptom may provide a valuable variable for developing a sunburn risk model.

P07. OPTIMIZATION AND IMPROVEMENT OF RECOVERING UNHARVESTED FRUIT: APPLICATION OF AN INTELLIGENT MOBILE ROBOT (FOODCOLLECT)

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Abstract: Tons of fruit are discarded at harvest time even though they are suitable for consumption or derived food uses. Many harvestable seasonal fruits are left on the field becoming food waste. The project FOODCOLLECT tries to address this problem, aligned with goal 12 (Responsible Consumption and Production) of the Sustainable Development Goals set by the ONU, incorporating value added products into the value chain. Further, the proposed solution will allow the reduction of fruit waste promoting sustainability, increasing the productive capacity of fruit orchards. Nowadays, there is no technological solution for picking fruits from the ground. We are proposing an innovative solution which can be a tool to optimize costs and improve working conditions and yield in the field introducing digital technologies.

AINIA has developed an equipment for automatic harvesting of fallen fruit. The prototype is composed by three new- fangled modules: Autonomous mobile robot with a GPS and vision sensors to monitor the field and obstacles; Intelligent vision system with 2D/3D cameras to identify the fruit and find the coordinates using artificial intelligence; Collaborative robot with a specific tool for harvesting fruit that meets food safety specifications. The whole prototype is safe and will collaborate with people around working many hours per day to maximize profits.

FOODCOLLECT's aim is to demonstrate that is possible to harvest fruit from the ground with an automated tool and food waste can be avoided providing other uses for fruit. With the fruit harvested from the ground, the next step would be to produce new products with added value such as natural ingredients for the food sector (essential oils, aromas, natural fiber, products for animal feed, among others) improving the efficiency of the food sector. We are promoting the change towards an efficient economy model where the value of the products is growing, and food waste is minimized, trying to increase the return for the farmers, avoid pests and rot caused by product degradation in the ground and generating new services with high-value digitized jobs with appropriate technology transfer.

Keywords: Robotics and automation; Precision agriculture; Artificial Intelligence; Upcycling food; Automated harvest

P08. EFFECTS OF PRE-PROCESSING COOLING TREATMENTS OF HARVESTED OLIVES ON OIL VOLATILOME AND QUALITY PARAMETERS

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Abstract: The olive (*Olea europaea* L.) crop is at the roots of the Mediterranean culture, and it is part of its heritage. Olive fruit quality strongly depends on environmental conditions. Climate emergency, with prolonged summers and warmer temperatures at harvest, is threatening the quality of the production. High temperatures during the latest developmental stages and at harvest, may promote oxidative reactions and induce negative effects on aroma, fatty acid, and polyphenol profiles of the resulting oil, and consequently, a reduced commercial life. To mitigate the risks and secure the olive oil quality, we herein report the results of trials regarding postharvest/pre-processing rapid cooling by means of cold-water treatments (by means of hydrocooling technology). The trials were performed in olives of the local varieties Frantoio and Leccino grown in Southern Tuscany (Italy). Analyses regarding olive oil quality and composition were performed on freshly extracted samples and one year after the production. Non-targeted Volatile Organic Compounds (VOCs) analyses were performed in addition to fatty acids and polyphenol content. The volatilome profiling indicate an increase of specific changes concerning C6 aldehydes, (known to be related to herbal/green flavor) after the postharvest/pre-processing cooling of olives in Frantoio cultivar. However, different responses were found in Leccino cultivar, showing in this way a genotype-dependent behavior regarding the volatile profile. Furthermore, significant changes in both cultivars were observed in the fatty acid profile in the fresh oil after the treatment while no trend was observed in polyphenol profiling in relation to the treatment. Unfortunately, the treatment seems to have limited effects on the oils analyzed after one year of storage, this could be possibly related to different oxidation reactions on specific VOCs, fatty acids, and polyphenols.

Keywords: Olive oil composition, VOCs, Olea europaea, postharvest cooling, temperature, polyphenols, fatty acids

P09. POTENTIALITY OF HYPERSPECTRAL IMAGING FOR AUTHENTICATION OF ROCKET LEAVES PRODUCED ACCORDING TO DIFFERENT WATER AND FERTILIZATION MANAGEMENT SYSTEMS

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Abstract: In this study we assessed the potentiality of hyperspectral imaging for the discrimination of different management systems for water and fertilizer use on rocket leaves. Soilless cultivation of rocket leaves was conducted in unheated tunnels combining 2 levels of fertilization with 2 irrigation management systems (sensor based and conventionally timer based), resulting in a factorial design. Reflectance spectra were acquired using Vis-NIR ranges between 400-1000 nm and NIR ranges between 900-1700 nm. After pretreatment spectra were used for discriminant models of the 4 treatments and for ANOVA-simultaneous component analysis (ASCA) in order to understand the effect of each factor on spectral response. Comparing four different treatments, PLS-DA model yielded the accuracy of 98.19%, 97.6%, and 97.2% for the cross validation, calibration and prediction system, respectively in Vis-NIR ranges while in NIR ranges the accuracy improved to 100%, 99.8%, and 99.5%. Moreover applying ASCA significant wavelengths were selected. Results indicated promising potentiality of hyperspectral imaging for the authentication of low input managed agricultural systems.

Keywords: Discrimination, Cultural practices, Non- destructive, PLS-DA, ASCA

P10. EFFECT OF MICROWAVE TREATMENT ON THE SENSORIAL AND NUTRITIONAL QUALITY OF POMEGRANATE ARILS (*PUNICA GRANATUM* L. VAR. WONDERFUL) UNDER MODIFIED ATMOSPHERE PACKAGING

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Abstract: Demand for minimally processed ready-to-eat pomegranate arils increased in the market over the past decade due to their high nutritional value, sensory characteristics, convenience, and health benefits. This study was aimed to assess the effect of microwave treatment combined with modified atmosphere packaging (MAP) on the shelf-life of pomegranate arils. A total of three replicate samples, each containing 100 g arils were treated in a microwave by using the power of 90 W, 160 W, 350 W, 500 W, 650 W for 10 seconds, then packed under modified atmosphere packaging (MAP) for 7 days, using a container of PET-PE and sealed by PET-PE plastic film (O_2 permeability at 500 cc/ m^2 24 h bar). Untreated arils were packed in the same conditions as control treatment. Samples were stored at 4 °C for 7 days measuring gas composition before opening and many quality attributes including sensorial, firmness, soluble solid content (SSC), total acidity (TA), microbial counts, total phenol, and antioxidant activity. The results indicated that pomegranate arils were best stored by using microwave of 90 Watt for 10 seconds allowing the shelf-life of 7 days, with no growth of psychrophiles, and maintaining higher firmness and best sensory attributes of excellent visual quality, sweetness level, and good odor with the hedonic scale of 5, 4.87, and 3 respectively. In control sample the growth of psychrophilic bacteria was 1.83 Log CFU/g and samples showed lower visual quality, sweetness level, and odor with the hedonic value of 3.2, 3.3, and 2 respectively, even if gas composition was similar to treated samples. Gained information is very important to improve the distribution of fresh pomegranate arils ensuring safety and high level of quality.

Keywords. Arils, microwave, modified atmosphere packaging, quality, sensory.

P11. NUTRITIONAL DIAGNOSIS OF CITRUS THROUGH THE USE OF VISIBLE AND NEAR-INFRARED HYPERSPECTRAL IMAGING

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Abstract: The deficiency or excess of a nutrient can alter the expected growth of the plant, leading to a decrease in the yield of the tree and the commercial quality of the fruit. The nutritional status is traditionally diagnosed through foliar ionomic analysis combined with other factors such as soil analysis to make recommendations for optimum fertilisation. These analyses require destructive measures that generate a high cost for the farmer. An alternative is the use of optical sensors, such as hyperspectral cameras. These cameras measure the electromagnetic energy reflected or emitted by the vegetation (spectral signature), which depends on the biochemical components of the plants. Alterations of these components, like nutritional deficiencies, produce changes in the tissue that are potentially detectable by these devices. This work uses visible and near-infrared hyperspectral imaging (400 – 1050 nm) to determine the concentration of primary macronutrients in citrus leaves non-destructively. Tests were carried out in a commercial citrus plot of clemetines cv. 'Nules'. 60 leaves (30 old, 30 young) were collected from 33 trees in three zones (east, west, and upper part) for a total of 180 leaves per tree (5940 leaves in all). Leaf ionomics was determined by inductively coupled plasma source emission spectrometry (ICP-OES) for phosphorous (P) and potassium (K), after microwave acid digestion and the Kjeldahl method for nitrogen (N) analysis. The average spectrum of each leaf was obtained. These spectra were used as predictor variables (X) and the concentrations of each nutrient, obtained by ionomics, as categorical variables (Y) to build models (one for each nutrient) based on partial least squares regression (PLS-R) to obtain predictions about the concentration of nutrients. The results obtained for an independent set of samples were R^2=0.71 (N), R^2=0.86 (P) and R^2=0.84 (K). These results were compared with other used vegetative indexes.

Keywords: foliar ionomics, precision agriculture, fertilisation, non-destructive, TCARI

P12. A SMART APPROACH TO EVALUATE BERGAMOT ESSENTIAL OIL CONTENT IN THE FIELD

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Abstract: Bergamot (*Citrus bergamia*, Risso et Poiteau) is an evergreen plant almost exclusively cultivated in a narrow coastal strip of about 150 km in Reggio Calabria Province (Southern Italy) where three cultivars are grown, namely: 'Fantastico', 'Femminello' and 'Castagnaro'. The fruit is mainly cultivated for its essential oil extracted from the peel and used in the cosmetic, perfumery and food industry. Such an essential oil has been claimed as the highest quality in the international commercial market and received the recognition of Protected Designation of Origin. The fruit is picked when the highest essential oil content in the peel is reached, but this aspect often depends on growers' experience and market requirements. One of the most used indicators is the peel colour, but its perception is subjective. The development of different analytical instruments such as portable spectrophotometers has allowed avoiding this subjectivity. Still, they enable analysing only the colour of a small sample area, making them unsuitable for heterogeneous conditions.

This research explores the development of an app for mobile devices on the Android platform, which allows stakeholders to quickly get information about bergamot fruit colour as an indicator of essential oil content. This would be possible thanks to a smart approach based on the acquisition of fruit pictures in the field using the camera of a mobile device coupled with a low-cost portable inspection chamber and subsequent imaging data analysis realised via machine learning algorithms. This could contribute to introducing digital technology solutions to enhance the competitiveness of the agri-food sector and support stakeholders to make smarter decisions for their production processes.

Hence, this paper reports the preliminary outputs related to the first experimental steps, suggesting the accuracy of colour assessment based on the analysis of bergamot images obtained by a mobile camera instead of conventional analysis using the portable spectrophotometer.

Keywords: Bergamot fruits, image analysis, mobile camera, machine learning, Android.

P13. NEW MODEL FOR THE AUTOMATIC DETECTION OF ANTHRACNOSE IN MANGO FRUITS BASED ON VIS/NIR HYPERSPECTRAL IMAGING AND DISCRIMINANT ANALYSIS

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Abstract: Anthracnose is one of the most relevant diseases of mango crops in producing regions, affecting 40% production. Detection is carried out in late stages by human visual inspection. Hyperspectral imaging systems allow the development of non-destructive solutions to inspect and detect internal damage. The objective of this work was to develop a system for the early detection of anthracnose in mango fruits using Vis/NIR hyperspectral imaging and discriminant analysis (DA). 60 mango 'Kent' were selected from a commercial farm in Malaga (Spain) with a similar physiological maturity (size and colour) and without visible lesions. The fruits were disinfected and separated into two groups, 10 for control and 50 for infection detection. All the fruits were punctured 6 times in the equatorial zone. In the control fruits, the wounds were covered with water, while in the target fruits, the wounds were covered with *Colletotrichum gloeosporioides* sp. at a concentration of $1x10^6$ spores/ml. The fruits were stored in a controlled chamber at 23 ºC for 12 days. From day 2 after inoculation, daily images of each fruit were captured with a hyperspectral system (450-980 nm) for 8 days. 277.940 spectral signatures were extracted from the images and labelled by group and day of acquisition, resulting in 9 classes: 1 class for the control group and 8 for the inoculated group. A classification model was obtained based on discriminant analysis and Tukey's statistic (for the variable selection). The model was trained with 70% of the signatures, and the remaining 30% were used for external validation. Results to separate the 9 classes achieved accuracy=0.909%, Kappa=0.898, specificity=0.989, sensitivity=0.929, and F1=0.916. With the Tukey statistic, 20 relevant wavelengths were selected, achieving an accuracy=0.798%, Kappa=0.772, specificity=0.975, sensitivity=0.82, and F1=0.803. This reduced model could be the basis of a potential detection system of anthracnose in mango fruits with multispectral cameras.

Keywords: *Mangifera indica* L, image analysis, automatic inspection, fruit quality

P14. MINERAL NUTRIENT COMPOSITION OF LEAVES AND FRUITS OF 'ROJO BRILLANTE' AND 'SHARON' PERSIMMON CROP

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Abstract: Spain is one of the main persimmon-producing countries, where 'Rojo Brillante' (RB) and 'Sharon' (SH) are the main cultivars grown, mainly commercialized for their high firmness flesh. It is known that fruit quality is related to the nutritional status plant, determined by foliar analysis. In persimmon, the mineral concentration of the fruit and its distribution through the flesh has been scarce studied. This study aimed to evaluate the concentrations of the macro and microelements in leaves and in two fruit flesh areas (basal and apical) of RB and SH persimmon. Both cultivars were grown following conventional practices in commercial orchards. Leaves were sampled in September, and fruit were harvested at their optimal maturity stage. The nitrogen (N) was determined by the semi-micro Kjeldahl method, and the other macro and microelements were determined by simultaneous inductively coupled plasma-atomic emission spectrometry (ICP-AES 6000). Leaves and fruit of SH had the highest N, while RB had the highest calcium (Ca) concentration in both tissues. Regarding flesh distribution, in SH, N and magnesium (Mg) were higher in the basal area. However, the basal area of RB exhibited a lower concentration of phosphorus (P) and potassium (K) but higher of Ca than the apical area. Boron (B) showed a similar pattern in both cultivars. The highest concentration was found in the apical area. Nevertheless, the B concentration in fruit was major in RB, although its leaves had the lowest concentration. Regarding Ca fractions, phosphates and carbonates were higher in RB than in SH. Ca-pectate, the Ca fraction with a structuring function, has different flesh fruit distribution depending on the cultivar. In SH, the highest Ca-pectate was found in the apical area, but it was observed in the basal area in RB.

The different nutrient distribution observed in the flesh of RB and SH should be considered when addressing possible variety-dependent physiological disorders.

Keywords: macronutrients, micronutrients, calcium fractions, pectate

P15. DETECTION OF ANTHRACNOSE IN MANGO CV 'KEITT' USING HYPERSPECTRAL IMAGING AND ARTIFICIAL NEURAL NETWORKS

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Abstract: Anthracnose is one of the main postharvest problems in mango fruits due to its high incidence. With the rise of artificial neural networks (ANN) and hyperspectral systems, the development of non-destructive solutions applied to the early disease detection in fruits has been promoted. The objective of this work focuses on the assessment of neural models for the spectral characterisation and detection of anthracnose in mango fruits, through the analysis of Vis/NIR hyperspectral images. A total of 60 mangoes 'Keitt' were collected from a producing farm in Malaga (Spain) with similar physiological maturity (size and colour). Fruits were disinfected, separated into two groups, 10 for control and 50 to detect the infection, and stored for 10 days in a controlled chamber at 23ºC. Six wounds were made in each fruit in the equatorial zone and covered with distilled water on the control group and with a spore suspension of *Colletotrichum gloeosporioides sp.* on the target group. Images were captured using a hyperspectral inspection system in the 450-980 nm range for 6 days, starting on day 2 after inoculation. 53,729 spectral signatures were grouped by acquisition day and type: one class for the control group and six classes for the inoculated group. Two neural models, based on one-layer (OLP) and multilayer (MLP) perceptron, respectively, were trained with 70% of the signatures, while the remaining 30% was used for external validation. In addition, the most relevant wavelengths were selected by PCA and Random Forest. OLP was the model with the best performance for the full range, with accuracy=0.967, specificity=0.994, sensitivity=0.968, and F1= 0.968, while MLP-PCA achieved the best result using 20 wavelengths with accuracy=0.894, specificity=0.982, sensitivity=0.889 and F1=0.888. Results show the potential of the ANN for the spectral characterisation of anthracnose in mango.

Keywords: *Mangifera indica* L, artificial neural networks, hyperspectral analysis, fruit quality.

P16. SPATIAL PREDICTION OF SOIL ORGANIC CARBON USING SENTINEL 2A

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Abstract: Soil organic carbon (SOC) is a key indicator of soil fertility and soil quality. It is an inseparable component of the global carbon cycle. The purpose of this study is to develop a model for predicting SOC using Sentinel-2A satellite imagery and geographic information system in the municipality of Oued el Alleug, Mitidja plain, Algeria. The modeling was performed using the stepwise linear regression (SLR) model. A total of 55 composite soil samples were collected at random from the study area using an auger (0 to 25 cm). The SOC stock ranged from 1.8 t C ha^{-1} to 72.7 t C ha^{-1}, with a mean value of 28.8 t C ha^{-1}. Based on these results, it appears that the soils of the study area are low in organic matter. The nature of soils and agricultural practices are the determinants of the spatial distribution of SOC in the study area. The results showed also that it is possible to use the band B2 to map the spatial distribution of SOC ($p < 0.05$). The prediction model presented acceptable performances, with a coefficient of determination $R^2 = 0.5$ and an RMSE = 6.73 g / kg in validation. Although the model is satisfactory, nevertheless, the error of the prediction model could be improved by increasing the number of samples in calibration. The results of this study are of great importance as they will facilitate decision-making in terms of soil conservation practices.

Keywords: soil organic carbon, Sentinel 2-A, spectral bands, prediction model, GIS.

P17. FLUORESCENCE EMISSION LEVEL UNDER ULTRAVIOLET LIGHT OF DIFFERENT CITRUS VARIETIES FOR DECAY DETECTION

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Abstract: Fungal infections of citrus develop rapidly during fruit storage and transportation periods, causing significant postharvest economic losses. The most serious is caused by the fungus Penicillium digitatum, which infects the fruit through wounds in the skin and causes rotting that can go unnoticed by the human eye because, in the initial stages, the colour of the infected skin is very similar to that of healthy skin. This makes it challenging to detect diseased fruit during quality control processes at packinghouses. The most used method to detect this disease is to illuminate the fruit with ultraviolet (UV) light since it causes the emission of fluorescence in the infected area that is detectable by trained inspectors. This personnel must carry out the inspection in dark rooms where the fruit is illuminated with UV light, which is dangerous for human skin. An alternative is to use artificial vision systems mounted on electronic sorters. But not all fruits show the same level of fluorescence, and even some varieties do not have this phenomenon, making it difficult to create effective automatic detection systems. This work has studied and determined the level of fluorescence of 117 varieties of oranges and tangerines. Six fruits of each variety were measured. Five of them were inoculated with the fungus, and the fluorescence of the decay lesion caused by UV light was measured with an artificial vision system. Images of all fruits were captured under the same conditions, and healthy fruits without apparent damage were used as controls. For each variety, the level of fluorescence they produce has been determined.

Keywords: citrus inspection, rottenness, image, ultraviolet

P18. UNTARGETED METABOLOMICS REVEALS DIFFERENTIAL RESPONSE UNDER WATER STRESS ON LEAVES OF SELF-GRAFTED AND GRAFTED ONTO A TOLERANT ROOTSTOCK PEPPER PLANTS.

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Abstract: Water stress has become one of the principal threats to agriculture, and the situation is getting worse in the context of global warming, with larger frequency of droughts and irregular rain episodes (FAO, 2022). The present and predicted future scenarios require solutions to deal with drought effects on agriculture, which lead to great losses in productivity and yields. One successful strategy to cope water stress is grafting onto tolerant rootstocks, as it has been proved in numerous studies (Penella et al., 2014, Yao et al., 2016, López-Serrano et al., 2019). However, there are a few studies employing "omics" sciences, which have lately raised as effective tools to understand the tolerance or sensitive response to abiotic stress in grafted plants (Lu et al., 2020). Specifically, metabolomics can be used to point out changes in metabolites composition of water stressed plants both in rootstock and scion, leading to a better comprehension of mechanisms involved in overcoming water stress (Lucini et al., 2020). In this study, untargeted metabolomics was applied to assess differences in the metabolic profile of leaves of self-grafted plants (V/V) and grafted plants using the tolerant rootstock NIBER® (V/N) (Gisbert-Mullor et al., 2020) exposed to water stress conditions by 5% PEG addition, with the aim of determining biochemical changes induced by NIBER® tolerance. Untargeted metabolomics showed a clearly different metabolic profile for control and stress conditions, but also for V/V and V/N. Although stress conditions lead to activation of common metabolic pathways in both genotypes, they differ mainly in modulation of amino acid synthesis, fatty acid and lipid synthesis (especially for hydroxylated and unsaturated fatty acids, phospholipids and sterol) and carbohydrates synthesis (particularly for oligosaccharides and sugar-nucleotides). To a lesser extent, differences between V/V and V/N were also found for nitrogen-containing compounds, hormones and electron carriers when comparing stressed and control plants from the same genotype. This study provides a preliminary evaluation of the metabolomic profile on leaves of self-grafted or grafted pepper plants using a tolerant rootstock and could help to understand how the plants react to water stress depending on their tolerance from a metabolomic perspective.

Keywords: *Capsicum annuum*, metabolism, grafting, drought

P19. THE SCIENCE BEHIND LETTUCE MICRO AND BABY LEAFS: THE FOOD OF THE 21ST CENTURY

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Abstract: Lettuce is the main raw leaf vegetable consumed worldwide, highly demanded in diets due to its high water content and low calories, so its nutraceutical fraction (minerals and functional compounds) is of particular relevance. In this sense, the use of indigenous varieties or landraces is a promising strategy to meet consumer demands, as well as helping to preserve biodiversity. In addition, the consumption of microgreens and baby leaves has gained consumer interest. However, very little is known about their nutritional value, especially in comparison with adult formats. Therefore, 11 lettuce varieties (6 local landraces (L) and 5 commercial (CL)) were selected to analyze the quality of the plant at three development stages (micro and baby-greens in clear current trend, and in adult format). The content of bioactive compounds such as ascorbic acid, anthocyanins and phenols, as the main antioxidant compounds found in lettuce was monitored. Ascorbic acid and phenolic content was 42% and 79% higher, respectively, in the early stages of development than in adult lettuces, with red leaf varieties (CL4 and L11) standing out. Concerning anthocyanin content, a clear pattern was observed, where microgreen lettuces had higher pigment content (mean value of 50.7 and 56.2 µmol 100 g^{-1}), except in CL4, L10 and L11, which showed higher anthocyanin concentration in baby and adult stages. Moreover, the nutritional value of adult lettuce is conditioned by the size, shape and structure of the head, as the concentrations of phytochemicals are regulated by light. Therefore, a lower content of ascorbic acid, phenols and anthocyanins was observed in iceberg lettuce (CL5), as the variety with the overlapping between leaves (49,67% and 27% less, respectively, than the average of the rest of the varieties in the adult stage). The results of this research highlight the wide variability in the nutritional characteristics of lettuces and underline that traditional varieties are a useful source of agricultural biodiversity.

Keywords: antioxidant; biodiversity; baby leaf; lettuce; microgreen

P20. ANTIOXIDANT CAPACITY, TOTAL PHENOLS, ORGANIC ACIDS, AND SUGARS OF BREBA, FIGS AND LEAVES OF *FICUS CARICA* (L.) CV. COLAR

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Abstract: The cultivation of *Ficus carica* is part of traditional Mediterranean agriculture. In the southeast of Spain, the Colar variety is the most widely grown. This variety produces two crops a year, the parthenocarpic breba, and the main non- parthenocarpic crop, the fig. The differentiation between the fruits of *Ficus carica* (L.) cv. Colar (breba and fig) as well as his parts (peel and pulp) and leaves still not been sufficiently studied. The aim of this study was to compare antioxidant activity (DPPH, ABTS, and FRAP assays), total phenols, and organic acid and sugar profile between brebas (peel and pulp), figs (peel and pulp) and leaves. The greatest antioxidant activity by DPPH assay was found in breba pulp (77.96 mM Trolox dw, dried weight), while the lowest value by ABTS assay was detected in fig pulp (6.56 mM Trolox dw). Related to organic acid and sugar profile, the majority acid was malic acid, being the greater concentration found in fig pulp, 29.47 g L^{-1} dw), followed by breba peel (28.11 g L^{-1} dw) and fig pulp (26.61 g L^{-1} dw). Both breba and fig peels presented higher values of total phenols (14.93 and 14.72g GAE kg-1 dw, respectively) than pulp (3.87 and 3.53 g GAE kg^{-1} dw, respectively).

Keywords: parthenocarpic, non-parthenocarpic, quality parameters, organic and sugars profile, antioxidant capacity

P21. USE OF VACUUM IMPREGNATION AS A TECHNOLOGY TO REDUCE SOAKING TIME AND TO INCREASE IRON CONTENT IN PULSES

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Abstract: Vacuum impregnation (VI) technology is based on the depressurisation and later the reestablishment of atmospheric pressure of a solid product-solution system, accelerating the entry of the solution into the product. The objective of this study was to use this technology during the soaking period of pulses with the aim to decrease the soaking time while incorporating iron into the system.

In order to select the pulse used in the study, the porosity of different pulses (chickpea, soybean, lentil, navy bean, green pea, and broad bean) was measured as it is an important factor in the effectiveness of the impregnation. Among them, broad bean was the pulse selected for this study as it showed the highest porosity, with values close to 11 %. The hydration kinetics was carried out with and without VI. To evaluate whether the soaking medium influenced the hydration kinetics, soaking with VI was repeated using an iron solution. After soaking, pulses were steam-cooked in an autoclave to check the effect of cooking on the incorporated iron. Finally, the iron content in the pulses (raw, soaked, and cooked) was determined spectrophotometrically.

The results indicated that the use of VI during soaking significantly reduced the hydration time. So, soaking at atmospheric pressure required 593 min to reach a 100 % hydration rate whereas using VI required only 136 min. The use of the iron solution as a soaking medium did not affect the hydration kinetics, and the iron content of broad beans was increased 2.7 times compared to broad beans soaked in water. After cooking, broad beans lost 23 % of the added iron but still kept 2 times more iron than broad beans soaked in water.

In conclusion, the use of VI during soaking reduced the soaking time by 77 % and this processing step could be used to enrich the broad beans in a water-soluble compound such as iron, obtaining broad beans with an iron content 2.7 times higher after soaking and 2 times higher after soaking and cooking.

Keywords: Vacuum impregnation, soaking, broad bean, enrichment, iron.

P22. EFFECT OF HARVISTA® APPLICATION ON QUALITY OF COLD STORED 'ROJO BRILLANTE' PERSIMMON

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Abstract: 1-methylcyclopropene (1-MCP) is routinely applied to persimmon 'Rojo Brillante' as a postharvest treatment (Smartfresh®) prior to cold storage to alleviate the firmness loss that occur as the main chilling injury symptom. Nevertheless preharvest 1-MCP treatment (marketed as Harvista®) (HV), and applied as a liquid spray to trees, is a novel treatment for maintaining fruit quality throughout the postharvest in some crops. Scarce information on the application of HV in persimmon is available. This study aimed to evaluate the effect of the application of HV three days before harvesting on firmness maintenance during cold storage of 'Rojo Brillante'. Fruit collected at two harvest dates, November 16 and November 30, was stored during 30 or 60 days at 0ºC plus 6 day at 20ºC simulating shelf-life period. Three treatments were compared: 1) Control (CTL) (fruit without HV treatment); 2) HV (fruit treated with Harvista three days before harvesting); 3) SF (fruit treated with Smartfresh® after harvesting). At harvest and after different storage periods flesh firmness and external color were determined. The preharvest application of 1-MCP (HV) had the same effect on maintaining the fruit firmness as the post-MCP application (SF) during the cold storage. Therefore, replacing the post-harvest application of Smartfresf® with the pre-harvest treatment of Harvista® can be a very useful tool to improve handling operations in packing houses.

Keywords: firmness, 1-MCP, Smartfresh,

P23. EFFECT OF DEASTRINGENCY TREATMENTS WITH ETHANOL AND CO_2 ON QUALITY OF COLD STORED 'GIOMBO' PERSIMMON

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Abstract: Persimmon cv. Giombo belongs to the pollination-variant astringent group (PVA), which develops by parthenocarpy and present total absence of seeds. Cultivars of this group have high level of soluble tannins until maturation, requiring a postharvest deastringency treatment before consumption. Currently, although the removal of astringency is mainly indicated by exposing the fruits to an atmosphere with high concentrations of CO_2, it is still commonly made by exposing the fruit to ethanol vapor. In this sense, the objective of this work was to compare physiological responses and structural changes of 'Giombo' persimmon treated with ethanol and CO_2 during posterior cold storage at 1ºC. Fruit were evaluated at 15, 25 and 40 days, after cold storage and after shelf-life simulation (5 more days at 20 ˚C). At each period, physicochemical and microstructural analysis were performed. CO_2 treatment reduced the soluble tannins to 0.1% after one day of application (before entering the cold chamber), while this % was reached with ethanol only after 25 days of cold storage. The present study also revealed that the flesh softening was faster in fruit treated with ethanol, noticeable after 15+5 days of shelf-life. After 40 days of cold storage, the fruit treated with CO_2 remained firmness values higher than 10 N, while in fruit treated with ethanol it was close to 6 N. The firmness loss was related to microstructural changes such as tonoplast degradation, cell decompartmentalization and loss of cell cohesion during the storage period, which was more evident in fruit treated with ethanol than those treated with CO_2.

Keywords: Fruit deastringency, flesh firmness, cold storage.

P24. EFFECT OF ROOTSTOCK ON THE BIOACTIVE COMPOUNDS OF MANDARINS

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Abstract: Citrus is one of the main cultivated fruits worldwide and the mandarin production has reached 38 million tons in 2020, and Spain is one of the larger producers. Selection of optimal rootstock is crucial for commercial cultivation of citrus fruit, as the effect fruit production, tree size, and biotic and abiotic tolerance.

The objective of this study was to identify the influence of 3 rootstocks (Carrizo citrange, C-35 citrange and Forner-Alcaide 5) on the volatile composition of two mandarin, 'Clemenrubí' and 'Orogrós' clementines.

Rootstock may affect internal quality parameters of citrus fruits, including juice total, soluble solids, acidity, antioxidant capacity, sugars and organic acids content, flavor. In this study, we evaluated the effect of three rootstocks on physicochemical parameters, sugars and organic acids, total antioxidant activity, total phenolic, crude fibre content and flavonoids.

The results indicate that the effect of rootstock on the physicochemical parameters, antioxidant activity, total phenolic, sugars and organic acids and flavonoids of clementines fruits is a rather complex phenomenon that greatly depends on specific interactions between the rootstock and each particular scion variety.

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NOTES

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