



SOCIETÀ ITALIANA DI FITOCHIMICA E
DELLE SCIENZE DELLE PIANTE MEDICINALI
ALIMENTARI E DA PROFUMO



DIPARTIMENTO DI CHIMICA E FARMACIA
UNIVERSITÀ DEGLI STUDI DI SASSARI

XVI CONGRESS OF THE ITALIAN SOCIETY OF PHYTOCHEMISTRY

JOINTLY WITH

*2nd International Congress on Edible
Medicinal and Aromatic Plants
(ICEMAP 2019)*



19-21 June 2019

Hotel Catalunya – Sala Convegni

Alghero (SS)

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XVI CONGRESS OF THE ITALIAN SOCIETY OF PHYTOCHEMISTRY
2st International Congress on Edible, Medicinal and Aromatic Plants (ICEMAP
2019)

Alghero, 19-21 June 2019

Programme

Wednesday, 19 June
2019

- 12:00-14:30 Participants registration
14:30-15:00 Opening ceremony
- (Chairperson: L. Pistelli, A. Bisio)
- 15:00-15:40 **Plenary Lecture**
PL1 - Frederick Bourgaud: Plant Advanced Technologies – Vandoeuvre “*«Please, baby, reconsider me »: a new set of technologies to reconcile natural plant compounds and pharmaceutical industry*”
- 15:40-16:40 **Oral Communications**
- 15:40-15:55 **OC1 - Najar Basma,** Mecacci Giulia, Pistelli Luisa, Cervelli Claudio, Mancianti Francesca, Ebani Valentina Virginia, Nardoni Simona
“*Antifungal and antimicrobial activity of essential oils from some Salvia and Helichrysum species*”
- 15:55-16:10 **OC2 - Marco Biagi,** Paolo Governa, Elisabetta Miraldi, Anna Rosa Magnano, Daniela Giachetti
“*Phytochemical characterization and gastroprotective activity of Copaifera langsdorffii Desf. oleoresin and fruit methanolic extract*”
- 16:10-16:25 **OC3 - Massimiliano D’Ambola,** Soumia Belaabed, Valentina Parisi, Francesca Pedrelli, Ammar Bader, Roberta Cotugno, **Angela Bisio,** Nunziatina De Tommasi
“*Cytotoxic labdane diterpenes from Premna resinosa (Hochst.) Schauer*”
- 16:25-16:40 **OC4 - Matteo Caser,** Sonia Demasi, Dario Donno, Valentina Scariot
“*Crocus sativus L. as a strategic crop for local farms in western Italian Alps*”
- 16:40-17:00 **Coffee Break**
- (Chairpersons: R. Caniato - L. Menghini)
- 17:00-17:40 **Plenary Lecture**

PL2 - Annalisa Romani: Università degli Studi di Firenze, Italy

“Bioactive compounds production by Circular Integrated Models and their innovative uses”

17:40-18:25

Oral Communications

17:40-17:55

OC5 – Iannuzzi Anna Maria, Braca Alessandra, Sinisgalli Chiara, De Leo Marinella, Milella Luigi, Ostuni Angela, Giani Sergio and Sanogo Rokia

“Adansonia digitata L. (baobab) from Mali: phytochemical profile, antioxidant and antidiabetic activities of its fruit pulp and leaves “

17:55-18:10

OC6 - De Martino Laura, Elshafie Hazem S., Grul’ová Daniela, Baranová Beáta, Caputo Lucia, Sedlák Vincent, Camele Ippolito, De Feo Vincenzo

“Solidago canadensis L.: a dangerous plant invader as possible pest control”

18:10-18:25

OC7 - Demasi Sonia, Najar Basma, Matteo Caser, Lonati Michele, Gaino Walter, Pistelli Luisa, Scariot Valentina

“Variability of flower traits and essential oil composition in Lavandula angustifolia Mill. of western Italian Alps cultivated on different substrates”

18.25-18:40

OC8 - Francesco Fancello, Giacomo Petretto, Salvatore Marceddu, Tullio Venditti, Giorgio Pintore, Giacomo Zara, Ilaria Mannazzu, Marilena Budroni, Severino Zara

“Antimicrobial activity of gaseous Citrus limon var pompia leaf essential oil against Listeria monocytogenes on ricotta salata cheese”

18:40-18:55

SIF student Grants and ZONTA grant

18:55- 19:30

Annual SIF Meeting

20:00

Welcome Cocktail

**Thursday, 20 June
2019**

- 08:30-09:00 Participants registration
- (Chairperson: R. Caniato, A.R. Bilia)
- 09:00-09:40 **Plenary Lecture**
PL3 - Sonja Sturm: University of Innsbruck, Innsbruck, Austria
“Natural product analysis: trends, challenges and pitfalls in an “omics” world”
- 09:40-10:55 **Oral Communications**
- 09:40-09:55 **OC9 - Ferrante Claudio,** Zengin Gokhan, Senkardes Ismail, Gevrenova Reneta, Zheleva-Dimitrova Dimitrina, Orlando Giustino, Recinella Lucia, Chiavaroli Annalisa, Leone Sheila, Brunetti Luigi, Picot-Allain Carene Marie Nancy, Rengasamy Kannan RR, Mahomoodally Mohamad Fawzi
“Phytochemical and pharmacological profile of Rubus sanctus and Rubus ibericus extracts”
- 09:55-10:10 **OC10 - Vittoria Graziani,** Odeta Celaj, Cinzia Sanna, Alexandra Garcia Duran, Francesca Esposito, Angela Corona, Enzo Tramontano, Rosangela Marasco, Elisabetta Buommino, Angela Ferro, Brigida D’Abrosca, Antonio Fiorentino
“Metabolomics and biological assays of Sardinian plant species to find secondary metabolites exerting anti-microbial and anti-viral activities”
- 10:10-10:25 **OC11 - Hayouni El Akrem**
“The power of combination of bioactive compounds from aromatic and medicinal plants and beneficial microorganisms: fermented-plant extratcs as example”
- 10:25-10:40 **OC12 - Giuliani Claudia, Bottoni Martina,** Santagostini Laura, Papini Alessio, Ascrizzi Roberta, Giovanetti Manuela, Lupi Daniela, Todero Sefora, Basilico Nicoletta, Fratini Filippo, Flamini Guido, Maggi Filippo, Fico Gelsomina
“The Ghirardi botanic garden, beyond the visible”
- 10:40-10:55 **OC13 - Marchese Jose Abramo,** Zanatta Jorge Luiz, Benato Josiane, Dall Agnol Laerte
“Production of highly effective and low cost antimalarial herbal medicine as alternative to monotherapy and artemisinin combination therapy”
- 10:55-11.20 **Coffee Break**
(Chairpersons: S. Benvenuti, F. Pollastro)
- 11:20-12:00 **Plenary lecture**

PL4 - Paola Brun: Università degli Studi di Padova, Italy
“Phytochemicals and gut microbiota: mutual interactions”

12:00-13:00

Oral Communications

12:00-12:15

OC14 - Marengo Arianna, Maxia Andrea, Sanna Cinzia, Mandrone Manuela, Berdea Cinzia M., Bicchi Carlo, Sgorbini Barbara, Cagliari Cecilia, Rubiolo Patrizia
“Ptilostemon casabonae (L.) Greuter: chemical and biomolecular analyses of a little-known Mediterranean endemism”

12:15-12:30

OC15 - Piccolella Simona, Crescente Giuseppina, Bianco Alessandro, Candela Lorenzo, Pacifico Severina
“New insights into Inula viscosa bioactive polyphenols”

12:30-12:45

OC16 - Marchioni Ilaria, Pistelli Laura, Ferri Benedetta, Copetta Andrea, Ruffoni Barbara, Pistelli Luisa
“May cold storage condition alters the metabolites and aroma of two edible flowers with lemon-flavour?”

12:45-13:00

OC17 - Matteo Politi, Luigi Menghini, Francesca Mustacchio, Barbara Conti, Stefano Bedini, Pierluigi Cioni, Marinella De Leo, Alessandra Braca
“Lavandin by-products development in a context of multifunctional agriculture: a case study in Tuscany”

13:00-14:30

Break for free Lunch

14:30-15:30

Poster Session

15:45

Visit to Capo Caccia Light House and Sant’Imbenia

20:00

Congress Social Dinner in “Tenute Delogu”

Friday, 21 June 2019

- (Chairperson: G. Pintore, L. Pistelli)
- 09:00-09:40 **Plenary Lecture**
PL5 - Saadia Zrira: Institut Agronomique et Veterinaire Hassan II, Agdal Rabat, Morocco *“Empowering Moroccan rural women through the valorization of aromatic and medicinal plants”*
- 09:40-10:40 **Oral Communications**
- 09:40-09:55 **OC18 - Risaliti Laura,** Pini Gabriella, Donato Rosa, Sacco Cristina, Ascrizzi Roberta, Vanti Giulia, Bergonzi Maria Camilla, Bilia Anna Rita
“Artemisia annua essential oils liposomes: optimization and in vitro antifungal activity evaluation against Candida species”
- 09:55-10:10 **OC19 - Scariot Valentina,** Demasi Sonia, Caser Matteo
“Domesticating wild species for edible flowers production”
- 10:10-10:25 **OC20 - Marinella De Leo,** Antonio Vassallo, Claudio Pisano, Alessandra Braca, Nunziatina De Tommasi
“Comparative analyses of different extraction procedures of italian propolis by HPLC-PDA/UV-ESI-MS/MS and evaluation of in vivo anti-inflammatory activity”
- 10:25-10:40 **OC21 - Vanti Giulia,** Dourdouni Virginia, Lazari Diamanto, Panagiotidis Christos, Piazzini Vieri, Risaliti Laura, Bergonzi Maria Camilla, Bilia Anna Rita
“Melissa officinalis essential oil loading-glycosomes for the topical appliance against herpes labialis (HSV-1)”
- 10:40-11:10 **Coffee Break**
- 11:10- 12:45 **Tavola Rotonda: Coordinano G. Pintore, L. Pistelli**
“La filiera delle Piante Officinali: quali prospettive con la nuova legge”
- 13:00 **Closing Ceremony**

PL1 - « PLEASE, BABY, RECONSIDER ME »: A NEW SET OF TECHNOLOGIES TO RECONCILE NATURAL PLANT COMPOUNDS AND PHARMACEUTICAL INDUSTRY”

Frédéric Bourgaud

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Plants have historically served as the most significant source of new leads for pharmaceutical development. Today, it is considered that about ¼ of our modern medicines contain plant-derived molecules. Despite this interest for natural plant products, there has been a clear decline over the last 3 decades for the development of plant-derived therapeutics. Concerns over the availability of a chemical entity required for development and market needs, have been one of the most limiting factors for the pharmaceutical industry’s interest in natural products. Another limiting factor lies under the paradigm “one illness/one molecule” that underpins modern drug development. This is clearly to the detriment of plant extracts that contain virtually thousands of active molecules, often displaying synergistic effects. We have revisited plant natural compound discovery by developing a new drug discovery program, based on terrestrial plant exploration (R&D settlement in La Réunion Island), phenotypical testing of targeted diseases (anti-inflammatory and antimicrobial activities), and original ligand-protein interaction technologies to discover new candidates among the vast plant natural chemodiversity. Our program has a special interest towards compounds found in plant roots, since these organs are most frequently used in traditional pharmacopoeia and constitute the richest plant tissues in terms of chemical diversity.

We have also reconsidered the production of chemical scaffolds of plant root origin by developing the so-called "*Plant Milking Technology*", where plants are cultivated on soilless systems in a confined greenhouse environment (now on 3,5 ha), giving a unique access to the root compartment for an efficient molecule recovery. Alternatively, we have developed genetic engineering programs where a set of carefully chosen plant genes, responsible for a given metabolic pathway, are implemented into microbial organism (heterologous expression in bacteria or yeast) for an efficient and low-cost production of rare natural plant compounds.

PL2 - BIOACTIVE COMPOUNDS PRODUCTION BY CIRCULAR INTEGRATED MODELS AND THEIR INNOVATIVE USES

Annalisa Romani^{a,b}, Chiara Cassiani^{a,b}, Margherita Campo^{a,b}

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²QuMAP Laboratory, PIN Polo Universitario Città di Prato

Waste and by-product plant materials usually contain a great biological potential that could be exploited by extracting bioactive compounds with high added value before using biomass for energy purposes, through efficient small or industrial scale bio-refineries, according to the modern circular agro-industrial models^{1,2,5,6,7}. The extraction techniques are usually based on *green* processes, using water or low percentages of ethanol as solvents, or super- or sub- critical fluids according to the chemical properties of the active principles that must be preserved from degradation. Where necessary, moderately high temperatures or ultrasounds can be applied to enhance the yields of extraction. The raw extracts are purified and concentrated by integrated sequences of filtration steps with different molecular cut-offs from microfiltration to reverse osmosis to produce concentrated fractions enriched in selected chemical subclasses of bioactive principles. The enriched fractions can be further concentrated under vacuum or spray-dried, which allows for a better stability and standardization of the final products. The exhausted material is suitable for the production of energy (bio-hydrogen and bio-methane, or combustion inside the boiler which supplies the heating plant). Each product is assessed by chromatographic, spectrophotometric and spectrometric (HPLC/DAD/ESI-MS) analysis, to identify, quantify and monitor the content of individual active compounds; further studies follow to investigate the biological properties of the concentrated fractions and to evaluate the industrial sectors of applications. The contents of active principles found for the enriched fractions are around 11% in gallic acid and hydrolysable tannins for the dried fraction of Sweet Chestnut^{2,5}; up to 25% polyphenols (mainly secoiridoid derivatives) for olive leaves concentrated fractions and 29% polyphenols (28% hydroxytyrosol derivatives) for pitted olive pulp concentrated fractions⁵⁻⁷; 935 mg/L total polyphenols for concentrated grape leaves extracts; 148 mg/L total polyphenols for concentrated extracts obtained from dried grape marcs, while the dried powder obtained from grape marcs showed a content of 13 mg/g total polyphenols. Grape seeds residue after mechanical oil extraction showed a content of 7% total procyanidins suggesting for their further exploitation to obtain concentrated fractions with antioxidant and antimicrobial properties¹. The process yields on dried extract are around 5% with respect to the row material, but they can vary based on the vegetal species and tissues extracted. The energy yields for olive paste after extraction were 0.369-0.161 tep/T biogas, 0.429 tep/T energy⁵. The markets concerned are, green agriculture, feed, food, cosmetics, pharmaceuticals, bio-polymeric materials and in addition that of energy¹⁻⁷.

1. Lucarini M., Durazzo A., Romani A., Campo M., Lombardi-Boccia G., Cecchini F. (2018) *Molecules*, 23(8), 1888; 2. Campo M., Pinelli P., Romani A. (2016) *Natural Product Communications*, 11(3), 409-415; 3. Bargiacchi E., Miele S., Romani A., Campo M. (2013). Proceedings of the 1st World Congress on the Use of Biostimulants in Agriculture, *Acta Horticulturae* ISHS, 1009, 111-116; 4. Bargiacchi E., Bellotti P., Costa G., Miele S., Pinelli P., Romani A., Zambelli P., Scardigli A. (2014). PCT 0001422367 Gruppo Mauro Saviola S.R.L.; 5. Romani A., Vita C., Campo M., Scardigli A. (2016) *Rivista delle Tecnologie Agroalimentari - Sistemi per produrre*. Year XXVII n.5 june/july 2016. p. 50-55; 6. Romani A., Pinelli P., Ieri F., Bernini R. (2016) *Sustainability*, 8, 1002; 7. Pizzichini D., Russo C., Vitagliano M., Pizzichini M., Romani A., Ieri F., Pinelli P., Vignolini P. and Phenofarm S.R.L. (Roma). PCT 2338500 (A1), dep. 29/06/2011.

PL3 - NATURAL PRODUCT ANALYSIS: TRENDS, CHALLENGES AND PITFALLS IN AN “OMICS” WORLD

Sonja Sturm

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Technological progress, novel application fields and the increasing interest to utilize natural “green” products in medicine, cosmetics and health related nutrition (nutraceuticals and functional food) mean a permanent driver of change in phytochemical sciences. Tightening regulatory requirements force producers and scientists to thoroughly characterize extracts, fractions or whole plant parts containing bioactive principles identified by newest pharmacological test systems.

The immense diversity of secondary metabolite structure classes and the necessity to handle a broad variety of matrices ranging from plant parts to processed food or biofluids imposes an increasing demand on instrumental analysis methods. The requirements for selectivity and sensitivity are met by the application of latest technologies ranging from hyphenated instrument setups including multi-stage mass spectrometry to NMR spectroscopy combined with multivariate data analysis. In a modern world of limited resources and the desire to minimize the ecological footprint of any undertaking, faster and / or “green” analysis implies an additional challenge for the modern analytical phytochemist.

A “green” revolution in separation sciences has definitively been triggered by technological advances in supercritical fluid analysis (SFC), which allows to complement or even replace organic solvent driven HPLC approaches in well researched classical phytochemical applications such as targeted metabolite profiling of *Gentiana sp.* NMR spectroscopy, on the other hand, well known to any phytochemist as structure elucidation tool and often used as pattern recognition method in -omics applications, matured to a quantitative method (qNMR) – with comparable quality to laborious HPLC analysis as exemplified for *Silybum marianum*. If however secondary metabolites, identified as active principles, must be selectively tracked in plants, processed food matrices or biofluids in a targeted manner, LC-MS/MS, is still the key technology. For example, it facilitates the quantification of lactotriptides, a compound class associated with cardioprotective effects, in milk products including yogurt from the Alto Adige region or can be used to control the distribution of biological pest control agents by monitoring their secondary metabolites, e.g. destruxins excreted by the fungus *Metarhizium anisopliae*.

If the effect of natural products is to be investigated in a system biology approach, targeted selective methodologies must be replaced by pattern recognition driven analytical platforms. Both in the ongoing VASCAGE project dedicated to unravelling the mechanism of vascular aging and in the Euregio project VITISANA dedicated to characterizing resistant *Vitis vinifera* cultivars LC-MS/MS or NMR based approaches are utilized to deepen the knowledge on the metabolite profile of the target organisms – wine and man.

PL4 - PHYTOCHEMICALS AND GUT MICROBIOTA: MUTUAL INTERACTIONS

Paola Brun

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The human gut houses an abundant and diversified community of microorganisms namely the gut microbiota that significantly affects the nutritional and health status of the host. Bacteria and fungi that compose the gut microbiota convert dietary nutrients and supply the host with carbon, energy, vitamins, and a mixture of microbial-activated metabolites¹. In this view, the gut microbiota is a suitable target for nutritional interventions aiming at maintaining or improving health conditions. As diet plays a fundamental role in shaping the composition and metabolic functions of the gut microbiota, dietary phytochemicals have recently been proposed as adjuvants for the treatment of conditions characterized by alterations in the gut microbial community. Indeed, polyphenols, carotenoids, and thiosulfates present in many edible plants normalize the microbial imbalance caused by antibiotic administration and regulate the health-related gut microbiota profile². Moreover, phytochemicals and the related metabolic products inhibit pathogenic bacteria and sustain beneficial bacteria thus exerting prebiotic-like effects³.

The gut microbiota however is endowed with an incredible ability to transform phytochemicals *via* metabolic reactions such as reduction, ring-cleavage, dihydroxylation, and demethylation. Gut microbiome hydrolyzes glycosides and glucuronides resulting in production of metabolites that are biologically more active, inactive, or toxic than the original compounds⁴. The concoction of different dietary substances and the by-products generated by the gut microbiome likely feed different microbial species thus altering the initial composition of the gut microbiota.

The mutual interaction between phytochemicals and the gut microbiota is largely overlooked but the understanding of such complex interaction may open a new frontier in natural product chemistry and eventually conceptualize the use of phytochemicals under specific dietary regimens or pathological conditions.

References

- [1] O'Keefe SJ. *Curr Opin Gastroenterol.* 2008;24:51-58
- [2] Wu XM, *et al.* *Nat Prod Rep.* 2018. doi: 10.1039/c8np00041g
- [3] Carrera-Quintanar L, *et al.* *Mediators Inflamm.* 2018;26:9734845. doi: 10.1155/2018/9734845.
- [4] Koppel N, *et al.* *Science.* 2017;356(6344). doi: 10.1126/science.aag2770.

PL5 - EMPOWERING MOROCCAN RURAL WOMEN THROUGH THE VALORIZATION OF AROMATIC AND MEDICINAL PLANTS

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Morocco, characterized by an arid and semi arid climate, has a great biological diversity and an abundant richness in Herbal, Medicinal and Aromatic Plants (HMAP). Its rich flora of 4200 species is marked by high endemism and with 600-800 species with aromatic and/or medicinal values.

Morocco is a traditional supplier of the world market in aromatic and medicinal plants. This activity concerns the exploitation of spontaneous plants as well as the cultivated ones. Several products (more than 70) are thus exported under the forms of dried plants for the food herbs trade. More than thirty species are used for the production of essential oils or other aromatic extracts intended primarily for the industry of perfumery and cosmetic and also for the preparation of hygienic products and the flavours formulation. Women have considerable indigenous and practical knowledge gained through long years of collection of aromatic and medicinal plants and herbs from their natural habitats and by their production on a small scale. However, their qualifications neither are recognized nor developed. In parallel the income that the women perceive for their participation in management, transformation and marketing of HMAP is not proportional to the role which they assume in these activities.

With an aim of increasing the benefits of rural women from their participation in the production, transformation and marketing of aromatic and medicinal plants, many projects have been launched in different regions of Morocco supported by several donors. The main activities of these projects are: i) Organization of rural women in female NGOs, ii) Building their capacities in different fields, ii) Implementation of a farming experiment of some aromatic and medicinal species, and a pilot processing unit, iv) Supporting the sale of cooperative products.

OC1 - ANTIFUNGAL AND ANTIMICROBIAL ACTIVITY OF ESSENTIAL OILS FROM SOME *SALVIA* AND *HELICHRYSUM* SPECIES

Najar Basma^a, Mecacci Giulia^a, Pistelli Luisa^{a,b}, Cervelli Claudio^c, Mancianti Francesca^{b,d}, Ebani Valentina Virginia^{b,d}, Nardoni Simona^d

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Generally regarded as safe¹ the use of essential oils (EOs) exponentially increased in the last decade and their antibacterial and antifungal activity are well documented^{2,3}. In this context after a phytochemical investigation of the EO composition of three *Salvia* species (*S. aurea* L., *S. dentata* Aiton and *S. x mendisabalii* (Sagredo ex Rosúa) Roma-Marzio & Galasso) and five *Helichrysum* spp. (*H. edwardsii* Wild, *H. cooperi* Harv., *H. foetidum* L. Cass., *H. odoratissimum* L. Sweet and *H. patulum* L. D.Don) their antimicrobial activity was tested. Two dermatophytes: *Trichophyton mentagrophytes* and *Microsporum canis*, two species of *Aspergillus* (*A. flavus* and *A. niger*) together with *Fusarium solani*, were chosen for the *in vitro* tests of their antifungal activity. The bactericidal efficacy on two species of *Staphylococcus* (*S. aureus* and *S. pseudointermedius*) was also evaluated.

All the plant species belong to the collection of the Centro di Ricerca Orticoltura e Florovivaismo (CREA, Sanremo, Italy) where they have been grown in same environment and cultural practices.

The EOs from *Salvia* species were characterised by their high percentage of monoterpenes which represented 96% of the identified fraction in *S. x mendisabalii* and more than the 68% in *S. dentata*. On the contrary *S. aurea* EO evidenced sesquiterpenes as the major class of compounds (68.4%). This latter class of constituents dominated in both the EOs of *H. foetidum* and *H. patulum* (83.3%, 66.2%, respectively), while in the other species of *Helichrysum* monoterpenes were present in the highest amount.

Regarding the antifungal activity, the tested dermatophytes were more sensible to the used EOs with very good inhibition after exposition to *S. x mendisabalii* and *H. edwardsii* EOs (MIC 0,25%). All the studied oils have proven to be mostly ineffective on the bacterial strains except for the *H. edwardsii* and *S. dentata* EOs, which showed slight activity only on *S. pseudointermedius*.

References

- [1] Reyes-Jurado, F., Navarro-Cruz, A.R., Ochoa-Velasco, C.E., López-Malo, A., Ávila-Sosa, R. 2019. Critical Reviews in food Science and Nutrition. DOI: 10.1080/10408398.2019.1586641
- [2] Chouhan, S., Sharma, K., Guleria, S. 2017. Medicines, 4(3): 58-79.
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OC2 - PHYTOCHEMICAL CHARACTERIZATION AND GASTROPROTECTIVE ACTIVITY OF *COPAIFERA LANGSDORFFII* DESF. OLEORESIN AND FRUIT METHANOLIC EXTRACT

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Copaifera langsdorffii Desf., Fabaceae, is a rainforest tree used in the traditional medicine of Brazil and South America to treat wounds, inflammation and gastric complaints. The antimicrobial activity of *C. langsdorffii* has been exhaustively highlighted [1].

The aim of this study was to investigate the biological properties of chemically characterized *C. langsdorffii* bark oleoresin and a methanolic extract of the fruit focusing on their gastroprotective effect [2]. We tested anti-*Helicobacter pylori* (HP) activity against 3 different strains both *cagA*⁺ and *cagA*⁻; the effect of *C. langsdorffii* on IL-6 release in LPS-stimulated human peripheral blood mononuclear cells was also evaluated. Finally, the toxicity of the samples was evaluated by means of *in vitro* test.

C. langsdorffii oleoresin was found to contain mainly sesquiterpene hydrocarbons and kaurane diterpenes, while methanol extract of the fruit was found to be rich in terpenoids, such as oxygenated sesquiterpenes and diterpenes, and polyphenols. Both the oleoresin and the fruit extract showed an interesting anti-HP activity, acting on different virulence strains. A strong reduction of IL-6 release was also observed.

C. langsdorffii terpenoids resulted fundamental for the biological activities, explaining previously published preclinical evidences. Nevertheless, the peculiar association between polyphenols and oxygenated sesquiterpenes and diterpenes, occurring in *C. langsdorffii* fruits could be considered a new interesting phytocomplex for gastroprotective purposes.

This work support the empirical use of *C. langsdorffii* in the Brazilian tradition and suggest further studies to be conducted, in order to better evaluate the potential of this species in the treatment of *H. pylori*-related gastric disorders.

References

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[2] Governa and Biagi. 2019. Plant Biosystems; in press.

OC3 - CYTOTOXIC LABDANE DITERPENES FROM *PREMNA RESINOSA* (HOCHST.) SCHAUER

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The genus *Premna* (Lamiaceae) contains 200 species mainly distributed throughout tropical and subtropical Asia, Africa, Australia, and the Pacific Islands.¹ 46 species are recognized in the Flora of China and 14 species in the Flora Malesiana area.¹ Most species in the genus are small trees or shrubs and rarely found as lianas and pyroherbs¹. Common metabolites of the genus are diterpenoids, triterpenoids, iridoid glycosides, flavonoids, lignans and xanthenes.^{1,2} The diversity of species of *Premna* throughout the habitat region results in various traditional uses by the local people,¹ to treat malaria, stomach and hepatic disorders, headache, cough, malaria and tuberculosis, infectious-related diseases, skin diseases, asthma, rheumatism, neuralgia, diarrhea and stomach disorder, hyperglycaemic, and obesity.^{1,2} Extracts and isolated compounds from leaves, root bark and stem bark have shown antioxidant, antibacterial, anti-inflammatory, cytotoxic, antifeedant and hepatoprotective activity.^{1,2} The essential oil obtained from *Premna* species displayed antibacterial properties.²

P. resinosa, a shrub or small bushy tree, with whitish stems and coriaceous leaves with a pleasant smell, is used in Indian traditional medicine, as laxative agent and to treat bronchitis. The extracts of *P. resinosa* and their flavonoid constituents showed cytotoxic, anti-tubercular, and antimicrobial activities.^{2,3}

The dichloromethane extract of the surface mixture, obtained from the fresh aerial parts of *P. resinosa*, was separated by different chromatographic techniques such as Silica gel, MPLC, and HPLC, and afforded five new and one known labdane diterpene whose structures were elucidated by NMR and MS Spectroscopy.

The antiproliferative activity of the isolates was investigated on Jurkat and HeLa cell lines. The most active diterpene (**1**) at 48 h showed activity in both cell lines (IC₅₀ of 13 ± 0.7 µM and 16 ± 0.9 µM, respectively).

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OC4- *CROCUS SATIVUS* L. AS A STRATEGIC CROP FOR LOCAL FARMS IN WESTERN ITALIAN ALPS

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Few spices are able to provide the combination of color, taste, and aroma to the foods and possess several nutraceutical properties for human health as saffron¹. In the present work we analysed the yield and quality of the saffron produced in three local farms located in the Western Italian Alps at different altitudes and pedoclimatic conditions during two cultivation cycles (2016-2018). Corm growth, flower production and saffron yields were monitored, and bioactive compounds content and antioxidant activity in the dried spice were analysed using spectrophotometry and high performance liquid chromatography. Growing season and environmental conditions significantly affected stigma yield, flower production, and plant growth. Corms produced more flowers in the second cultivation cycle (70.60 vs 34.60 flowers m⁻²). The pedoclimatic conditions affected the flower yield, which was higher in the farms located at lower altitudes respect to the others (mean of 56.60 vs 30.70 flowers m⁻², respectively). These differences could be due to the elevated incidence of wilting corms caused by high relative humidity and precipitation rate (more than 550 mm year⁻¹), that occurred at higher altitudes in both the studied seasons. Regarding the quality, the saffron produced in the three farms presented high quality (first ISO category) and high content of bioactive compounds. Specifically, quercitrin, epicatechin, and safranal content varied in the two cultivation cycles. The content of quercitrin decreased, while the mean of the other two compounds significantly increased. The environmental conditions affected gallic acid, crocin I, crocin II and vitamin C biosynthesis. The saffron produced at elevated altitudes was significantly superior in gallic acid and vitamin C, while the content of crocin I and crocin II was higher in the lowest. Taking together, all these findings provided an assessment of the high quality saffron production in the north west Italian Alps^{2,3}.

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**OC5 - ADANSONIA DIGITATA L. (BAOBAB) FROM MALI:
PHYTOCHEMICAL PROFILE, ANTIOXIDANT AND ANTIDIABETIC
ACTIVITIES OF ITS FRUIT PULP AND LEAVES**

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Adansonia digitata L. (Malvaceae), commonly called baobab, is a tree widespread in most of Sub-Saharan semi-arid and sub-humid region. Recently, its fruits attract a lot of interest as a food complement for their high nutritional value; in fact, the fruit pulp can be recommended for the daily intake of carbohydrates and proteins for children and pregnant women¹. The flour of baobab fruit pulp is popularly used in Africa to prepare refreshing drinks, sweets, and sauces, while in Mali is also used to treat the diarrhea of children and to stimulate the milk production in women. In African traditional medicine, the baobab fruit pulp is used as an antipyretic or febrifuge, anti-dysenteric, diaphoretic, immunostimulant, anti-inflammatory, analgesic, and probiotic remedy; baobab leaves are also known as antipyretic or febrifuge². Although these interesting features, only few studies are reported on its secondary metabolite content, with a high variability depending on the geographic region^{3,4}.

The aim of this study was to investigate the phenolic profiles of three sample fruits of Malian commercial baobab obtained from three different rural markets by HPLC-PDA/UV-ESI-MS/MS. Moreover, these samples were analyzed for their total phenolic content (TPC), antioxidant activity, and *in vitro* α -glucosidase inhibition. Results showed that all fruit pulp *n*-butanolic extracts exhibited a significant antioxidant activity and a higher α -glucosidase inhibition than acarbose used as standard. Baobab fruit pulps were found to be rich in procyanidins and flavonol glycosides, with tiliroside as the major constituent, while the leaves showed a similar profile respect to the fruits, but with more detected phenolics. These results indicated that Malian species baobab has a great potential as source of substances with high biological value. Furthermore, the different chemical compositions of pulp fruits compared to those from other African countries highlighted the influence of growing region on the chemical profile in term of secondary metabolites.

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OC6 - *SOLIDAGO CANADENSIS* L.: A DANGEROUS PLANT INVADER AS POSSIBLE PEST CONTROL

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The promising biological effects of many plants essential oils (EOs) encourage researchers to study their biochemical properties to be used as possible natural pesticides and not only as herbal medicines. Despite *Solidago canadensis* L. (Canadian goldenrod), Asteraceae family, is a dangerous plant invader in Europe, which suppress the indigenous flora, the current research has been conducted to evaluate the possible antimicrobial effects of its essential oil (EO) to control some common plant diseases caused by several postharvest phytopathogenic fungi (*Monilinia fructicola*, *Botrytis cinerea*, *Aspergillus niger*, and *Penicillium expansum*). Moreover, the antibacterial activity has been also carried out against some phytopathogenic bacteria Gram positive and Gram negative compared to the synthetic antibiotic Tetracycline. Minimum inhibitory concentration was carried out to determine the lowest effective EO dose using a 96-well microplate. The cell membrane permeability was also evaluated by measuring the electric conductivity (EC) to examine the possible mechanisms of action of *S. canadensis* EO. Chemical characterization of EO has been carried out using gas chromatography and mass spectrometry (GC-MS). Thirty-two identified components in *S. canadensis* EO presented 97.7% of total compounds in EO. The principal compounds were identified as germacrene D (34.9%), limonene (12.5%), α -pinene (11.6%), β -elemene (7.1%), and bornyl acetate (6.3%). In addition, *S. canadensis* EO demonstrated promising *in vitro* antimicrobial activities against the majority of tested phytopathogens at all tested concentrations.

OC7 - VARIABILITY OF FLOWER TRAITS AND ESSENTIAL OIL COMPOSITION IN *LAVANDULA ANGUSTIFOLIA* MILL. OF WESTERN ITALIAN ALPS CULTIVATED ON DIFFERENT SUBSTRATES

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Lavandula angustifolia Mill. (lavender) is a valuable medicinal and aromatic plant (MAP), with a great economic importance in perfumery, cosmetics, food manufacturing, aromatherapy, and pharmaceutical industry, greatly appreciated in the floriculture sector as well. It is the only wild lavender species that can be found in the Western Italian Alps, located between 500 and 1800 m of elevation. Altitudinal and latitudinal variations are known to influence both phytochemical and morphological characteristic of MAPs and might have differentiated some lavender ecotypes with peculiar characteristics^{1,2,3,4}. In this study, the diversity of *L. angustifolia* in Western Italian Alps was screened to identify interesting genetic resources, suitable for medicinal, aromatic and ornamental uses. Nine wild populations were sampled along Western Alps in different altitudes and latitudes and the areas were described with a phytosociological approach. As cultivation substrate composition may influence the plant secondary metabolism, plants were propagated by cuttings and cultivated under uniform conditions in a specialized nursery, testing three different substrates. After two cultivation cycles, essential oils were analysed and the main qualitative ornamental traits were recorded, following the evaluation of the International Union for the Protection of New Varieties of Plants (UPOV, TG/194/1 Rev.). Results highlighted variations of flower traits and essential oil profile according to the geographic origin of plants and the cultivation substrate composition. This knowledge allowed to identify genetic resources of potential interest for industrial applications or horticultural purposes and obtain information about the agro-technique.

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OC8 - ANTIMICROBIAL ACTIVITY OF GASEOUS CITRUS LIMON VAR POMPIA LEAF ESSENTIAL OIL AGAINST *LISTERIA MONOCYTOGENES* ON RICOTTA SALATA CHEESE

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Nowadays there is an increasing demand for natural food ingredients and additives, including natural antimicrobial compounds¹. Thus, to keep up with consumer trends, naturally derived substances, such as plant essential oils (EOs), as well as plant secondary metabolites are being considered as alternatives to synthetic antimicrobials^{2,3}. Recently the vapor treatment of food with volatile EOs has been proposed.

In the present study we analyzed the *in vitro* and *in vivo* antimicrobial activity of gaseous *Citrus limon* var *pompia* leaf essential oil (hereafter PLEO) and citral on ricotta salata cheese. The *in vitro* antilisterial activities determined using the disc volatilization method³, were concentration dependent.

For the *in vivo* analyses, sliced ricotta cheese was inoculated with *Listeria monocytogenes* 20600 DSMZ alone or together with two wild *L. monocytogenes* strains, subjected to mild hurdle technology with two different concentrations of gaseous PLEO and citral, and stored in a sealed polyethylene box.

Following these treatments, *L. monocytogenes* cell counts (expressed as CFU/g) revealed both gaseous PLEO and citral to exert a bactericidal effect on 20600 DSMZ and a bacteriostatic effect on the mix of *L. monocytogenes* strains. Scanning and transmission electron microscopy (SEM and TEM) analyses of *L. monocytogenes* cells suggested that PLEO targets the bacterial cell wall and plasma membrane. Chemical analyses of the liquid and vapor phase of PLEO indicated linalyl acetate to be the predominant compound, followed by limonene and the two isomers of citral. The chemical composition of PLEO was mainly in line with the findings of previous publications, with the one exception of linalyl acetate that was detected for the first time in the present study. Vapor analysis by solid phase microextraction coupled with gas-chromatography confirmed the presence of all crude oil components in the headspace of the box. These findings could be useful in order to develop strategies aimed at inactivating *L. monocytogenes* and potentially other foodborne pathogens developing on the surface of different cheeses, as well as food stuffs in general.

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OC9 - PHYTOCHEMICAL AND PHARMACOLOGICAL PROFILE OF *RUBUS SANCTUS* AND *RUBUS IBERICUS* EXTRACTS

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Rubus genus has been long used as food and medicinal source. Based on the multiple biological activities of several *Rubus* species, this study was designed to assess the inhibitory action of water, methanol and ethyl acetate extracts of *R. sanctus* and *R. ibericus* against key enzymes relevant to Alzheimer's disease (acetyl and butyryl cholinesterases), and type 2 diabetes (α -amylase, and α -glucosidase). The phytochemical compounds of the extracts were qualified by LC-MS. Finally, a pharmacological investigation was carried in order to explore protective effects of *R. sanctus* and *R. ibericus* extracts in an experimental model of ulcerative colitis, constituted by rat colon specimens challenged with lipopolysaccharide (LPS), *ex vivo*. We also investigated antiproliferative effects of *R. sanctus* and *R. ibericus* extracts, evaluated as inhibition of human colon cancer (HCT116) cell migration and invasion capacities (wound healing test). Hydroxybenzoic acids, hydroxycinnamic acids, acylquinic acids, ellagitannins, flavonoids, and triterpenoid saponins were determined using UHPLC-ESI/HRMS technique. The ethyl acetate and methanol extracts of the studied *Rubus* species inhibited effectively acetyl and butyryl cholinesterase thus supporting potential application in Alzheimer's Disease. By contrast, *R. sanctus* water extract showed low inhibition against α -amylase and prominent inhibitory action against α -glucosidase. This could suggest potential use of the extract in the management of type 2 diabetes. On the other hand, *R. sanctus* methanol extract was the most effective in blunting LPS-induced increase of colon levels of nitrites, malondialdehyde, lactate dehydrogenase and serotonin, thus suggesting protective effects in ulcerative colitis. The same extract was also able to inhibit spontaneous migration of HCT116 cells, in wound healing test.

Concluding, results of the present investigation showed the potential of the selected *Rubus* species as effective enzyme inhibitors and antioxidant/ant inflammatory agents. Moreover, *R. sanctus* methanol extract revealed the most active as protective agent in inflamed colon. This extract also displayed a significant inhibition of spontaneous migration of HCT116 cell line, thus suggesting a potential efficacy against migration and invasion capacities of human colon cancer cells. Further studies are warranted to isolate and characterize bioactive compounds present in the *Rubus* extracts, while the observed protective effects should be confirmed *in vivo*.

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OC10 - METABOLOMICS AND BIOLOGICAL ASSAYS OF SARDINIAN PLANT SPECIES TO FIND SECONDARY METABOLITES EXERTING ANTI-MICROBIAL AND ANTI-VIRAL ACTIVITIES

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Mediterranean area and Sardinia Island represent unique environments, whose complexity elicits the production of biologically active plant-derived molecules, including those exerting anti-microbial¹ and anti-HIV activities².

In this work, four plant species collected in Sardinia were selected: *Helichrysum saxatile* Moris *subsp. saxatile* (Asteraceae), *Plagiopus flosculosus* (L.) Alavi & Heywood (Asteraceae), *Scrophularia trifoliata* L. (Scrophulariaceae) and *Myrtus communis* L. (Myrtaceae). The first three are endemic Sardinian species, while the latter has a Mediterranean distribution. The main aim of this study was to find anti-microbial and anti-HIV molecules, which could in the future provide potential lead compounds for the developing of new pharmacological agents.

To this end, we performed a metabolomics analysis using 1D and 2D NMR techniques to identify the main phytochemical constituents present in the hydroalcoholic leaf extracts of the above-mentioned species. For the evaluation of the anti-HIV potential, we examined the inhibition of HIV-1 reverse transcriptase-associated ribonuclease H (RNase H) activity and HIV-1 integrase (IN) LEDGF-dependent in biochemical assays². We next assed the anti-microbial effect on selected gram-positive and gram-negative bacteria employing agar diffusion test and microdilution assay.

As a result, the metabolomics profiles revealed the presence of diverse secondary metabolites, which include feruloylquinic acid derivatives (*H. saxatile* and *P. flosculosus*), iridoids (*S. trifoliata*), flavonols and phloroglucinol derivatives (*M. communis*). Meanwhile, the biological screening unveiled that *M. communis* exhibits a strong inhibition of RNase H and (IN) LEDGF-dependent as well as a marked anti-microbial effect towards *Staphylococcus epidermidis* ATCC 35984. Major achievements of this study regard the identification of new phloroglucinol glycosides isolated from *M. communis* and characterized by a cyclohexadione moiety endowed with different alkylation patterns, which differ from those already described in literature.

In conclusion, this study contributes to the phytochemical characterization of endemic species of Sardinian vascular flora and, importantly, may pave the way for further investigations addressed to understand the mechanisms underlying the anti-HIV and anti-microbial activities of *M. communis* and its phloroglucinol glycosides.

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OC11 - THE POWER OF COMBINATION OF BIOACTIVE COMPOUNDS FROM AROMATIC AND MEDICINAL PLANTS AND BENEFICIAL MICROORGANISMS: FERMENTED-PLANT EXTRACTS AS EXAMPLE

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For centuries extracts have been used as elixirs for all sorts of ailments. Individuals would seek out certain plant materials that were known for their beneficial properties and ferment them to extract the desired benefits.

Weeds, green material as well as aromatic and medicinal plants can be valorized into organic beverages or organic liquids for many uses. During fermentation, selected bacteria encourage the breakdown of insoluble nutrients within the medium to release valuable bioactive substances, minerals, and other useful organic compounds.

Those natural deriving substances, consisting of herbal and botanical extracts and animal- and marine-based derived substances, will command the fastest growth among the three major groups of nutraceutical ingredients. Amongst these substances, Fermented-Plant Extracts (FPE) will lead gains, reflecting clinically proven physiological and therapeutic benefits and expanding uses as dietary supplements and nutritional values¹. The rising popularity of their homeopathic uses coupled with widespread trends promoting preventive medicine and pests/diseases control are major elements to focus on such products².

During this communication we will show major results of the chemical compositions and the biological activities of some FPE, as prepared by a specific way using selected plants and seeds. Indeed, some of them were very rich in polyphenols (ranging between 183 and 243 mg GEA/ml), flavonoids ranging between 86 and 107 mg RE/ml) and tannins (ranging between 73 and 95 mg CE/ml). Those beverages exhibited potent *in vitro* and *in vivo* antioxidant activities.

As pests and diseases control agents, some other FPE were prepared in order to enhance the overall situation of individuals and populations, cost effectively. The volatile composition of one interesting extract showed a profile rich in repellent and insecticidal compounds (1-8, cineole; diallyl sulfide, Disulfide, di-2-propenyl...). This extract exhibited a very interesting activity against major crops pests. This FPE showed also very promising fungicidal activities against many strains, even those resistant to main commercial fungicide: *Fusarium oxysporum*, *Fusarium graminearum*, *Aspergillus niger*, *Botrytis cinerea*, *Phytophthora infestans* (GL-1), *Phytophthora infestans* P3 4/91 R+, *Phytophthora infestans* P4 20/01 R.

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OC12 - THE GHIRARDI BOTANIC GARDEN, BEYOND THE VISIBLE

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Plants preserved in botanic gardens are primarily experienced for their aesthetic value, often losing their identity to give rise to a whole that welcomes visitors. However, beyond the visual display, each plant dialogues with the other living organisms through the production of a plethora of different secondary metabolites. In this perspective, botanic gardens become not only showcases of plant beauty, but also *factories of molecules* that drive multiple biotic interactions. Under this novel inquiring approach, botanic gardens may be explored for intrinsic features lying at a higher level than that visually perceived. In this framework, we planned a research project on 30 selected medicinal species preserved at the Ghirardi Botanic Garden (Toscolano Maderno, Bs) on the basis of their productivity in volatile compounds (VOCs), essential oils (EOs), epicuticular depositions and substances stored at tissue level. The project encompasses analyses on the: (i) micromorphology of the secretory structures; (ii) the chemistry of the secondary metabolites; (iii) the evaluation of their ecological roles and (iv) of their biological activity. By way of example, we presented hereafter the results of the investigations performed on some target-species for each of the three-scale analyses. (i) We addressed our attention on *Cinnamomum camphora* (L.) J.Presl. The structures responsible for oil synthesis and storage were secretory cells distributed in the foliar mesophyll, in the bark and in close association to the xylem medullary rays. (ii) We analysed the composition of the EOs obtained from the leaves of *Myrtus communis* L., following different preservation procedures: fresh, dried and stored at room temperature, dried and stored at -20°C, dried and stored at -80°C. A high level of chemical consistency emerged across the EOs, due to the occurrence of 11 common compounds that included the main constituents. (iii) We observed the peculiar handling strategies of the local insect visitors on the flowers of two Mexican sage species: *Salvia blepharophylla* Brandegee (ex Epling) and *Salvia greggii* A. Gray. (iv) We evaluated the antimalarial activity on *Plasmodium falciparum* chloroquine (CQ)-sensitive (D10) and CQ-resistant (W2) strains and the antileishmanial activity on *Leishmania infantum* and *Leishmania tropica* of the EO of *Eugenia uniflora* L. aerial parts. The cytotoxicity of the oils was evaluated on human cells to calculate the selectivity index. *E. uniflora* showed antimalarial and antileishmanial activity at micromolar concentrations, but exhibited high cytotoxicity.

The overall results were discussed in the light of the most recent literature contributions.

OC13 - PRODUCTION OF HIGHLY EFFECTIVE AND LOW COST ANTIMALARIAL HERBAL MEDICINE AS ALTERNATIVE TO MONOTHERAPY AND ARTEMISININ COMBINATION THERAPY

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Artemisinin (ART) (isolated from *Artemisia annua* L.) and its semi-synthetic analogues are the most effective active ingredients in malaria control and are used in monotherapy or artemisinin combination therapy (ACT). One of the problems of using monotherapy and ACT for the treatment of malaria is the high cost. The new effective drugs, artemisinin combination therapy (ACT), today cost less than US\$2.00 per course wholesale and can be marked up to five times that amount in pharmacies in Africa, too much for the poorest of the poor in every endemic country. Currently, WHO does not recommend the use *A. annua* plant material, including tea, for the treatment or the prevention of malaria. In order to receive a dose equivalent to a 500 mg artemisinin, patients would be required to drink as much as 5 liters of *A. annua* tea per day, for a minimum of seven consecutive days, making compliance to treatment difficult to achieve. In addition, the total recovery of artemisinin can vary from 0.01 to 0.03% weight of dry leaf, mainly in wild genotypes of *A. annua* that did not pass for any kind of plant breeding. At present, the emergence of artemisinin partial resistance in multiple locations, as in the Greater Mekong Subregion (Asia) or in Congo (Africa), and the emergence of multidrug resistance, causing ACT failure, has led WHO to look for new alternatives. Because of the strong effort of plant breeding programs, to increase the content of ART and analogues substances inside *A. annua* dry leaves, today we have elite genotypes with more than 1% of ART¹. Recently, dried leaf *A. annua* (DLA) has shown efficacy against *Plasmodium* sp. in rodent studies and in small clinical trials. Of 18 i.v. artesunate or ACT-resistant severe malaria cases compassionately treated with DLA, all fully recovered, suggesting that DLA should be rapidly incorporated into the WHO antimalarial regimen². In Brazil, two traditional breeding programs of *A. annua*, one from the Campinas State University (CPQBA/UNICAMP), and the other from the Federal University of Technology – Paraná (UTFPR), have united their programs and now we are developing *A. annua* genotypes containing high artemisinin (1.3% DLA) and dihydroartemisinic acid using agronomic, physiological and phytochemical characters for selection. Our selection is based on both artemisinin and dihydroartemisinic acid (DH), because high DH increases artemisinin in planta. Considering the elite genotypes developed for UNICAMP/UTFPR we opened a startup (Artemis Biopharma®) in UTFPR's Entrepreneurship and Innovation Program for the production of DLA tablets, a low cost antimalarial herbal medicine as an alternative to expensive therapies, as monotherapy and ACT.

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OC14 - *PTILOSTEMON CASABONAE* (L.) GREUTER: CHEMICAL AND BIOMOLECULAR ANALYSES OF A LITTLE-KNOWN MEDITERRANEAN ENDEMISM

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Ptilostemon casabonae (L.) Greuter (Compositae) is a Mediterranean endemism localized in Sardinia, Corse and Hyères islands (France) and it is traditionally used for its health-giving properties^{1,2}. In this study, several samples of *P. casabonae* were collected from Sardinia (Gennargentu and Iglesias) and Corse (Bocca di Tana), subjected to hydroalcoholic extraction of the aerial parts and DNA isolation. The extracts were subsequently analyzed with the aim to provide more information concerning the chemical and biomolecular patterns of this little-known species³. At the same time, the potential antioxidant activity of the hydroalcoholic extracts was also evaluated.

The phenolic composition of the extracts, investigated through HPLC-PDA-MS/MS, revealed similar chromatographic patterns of the samples from the three different sites, with flavonoids and caffeoylquinic acid derivatives as the main components. Nevertheless, some quantitative differences among the three extracts were detectable and confirmed by statistical analyses (PCA and ANOVA). The amplification and sequencing of two barcoding genes (*ITS* and *psbA*) and the *5s-rRNA-NTS* region revealed a stability in the nucleotide composition of the sequences belonging to the *P. casabonae* samples from different geographical origins. On the contrary, a Basic Local Alignment in Genbank showed an interspecific variability of *ITS* and *psbA* regions. Finally, the three extracts exhibited a similar antioxidant activity and interesting results compared to the positive controls (Trolox).

These findings provide useful information to depict and discriminate this little-known plant. The stability of the phenolic and biomolecular profiles can help in the identification of these species and the search for potential biological activities may support the traditional use of *P. casabonae* for medicinal and food purposes.

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OC15- NEW INSIGHTS INTO *INULA VISCOSA* BIOACTIVE POLYPHENOLS

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The renewed interest in medicinal and aromatic plants (MAPs) and a greater awareness of the potential benefits of some of their constituents have invested a large part of the scientific community. Furthermore, a marked increase in the demand/consumption of MAP-based products has affected the entire population, arousing the keen attention of the food, nutra- and cosmeceutical industries. Indeed, the advent of powerful analytical techniques is prompt to convey new insights in MAPs chemical constitution, opening up new scenarios for their qualified usage. In this context, our attention was devoted to *Dittrichia viscosa* (L.) W. Greuter, an herbaceous plant belonging to the Asteraceae family, also known as *Inula viscosa* (L.) Aiton. A simple experimental design, based on inula leaves Soxhlet extraction, using firstly chloroform and then methanol as extracting solvents, and chromatographic fractionation, allowed us to obtain a polyphenol fraction (IvE).¹ UHPLC-HRMS chemical profiling revealed forty-three secondary metabolites, among which shikimoyl depsides of caffeic acid and unusual dihydrobenzofuran lignans were the main constituents. These compounds, together with cinchonain-type phenols, and hydroxycinnamoyl flavonol glycosides, have never been reported in inula. IvE extract exerted a remarkable antiradical activity, and was able to inhibit cell viability and mitochondrial redox activity of neuroblastoma, hepatoblastoma and colon carcinoma cell lines, due to its ability to increase ROS intracellular formation. Contrariwise, IvE did not affect cell density and growth of HaCaT cells immortalized human keratinocytes. Data acquired encourage the employment of this wild renewable source for the obtainment of bioactive nutraceutical phytochemicals.

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OC16 - MAY COLD STORAGE CONDITION ALTERS THE METABOLITES AND AROMA OF TWO EDIBLE FLOWERS WITH LEMON-FLAVOUR?

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Edible flowers are traditionally used for human consumption, since the time of Chinese, Greek and Romans. The tradition was maintained over the centuries and nowadays it's common to find flower petals in different sweet and savoury recipes, since they are able to enhance the aesthetic value of food and improve its taste. Examples of the most common edible flowers are squash blossoms, violets, rose petals, borage and lavender flowers. Currently many papers show the presence of important bioactive compounds, responsible for their nutritional, antioxidant and antimicrobial properties, therefore edible flower demand is increasing worldwide (1,2). However, edible flowers are very delicate and their shelf life is limited; indeed loss of colour, wilting, dehydration, fast browning and petal abscission can compromise edible flowers' sales opportunities (3). The project ANTEA (UE INTERREG ALCOTRA IT-FR n.1139) aims to extend the use of edible flowers as functional food and enlarge the number of the species used for supply chain of the edible flowers.

In this study, two lemon-flavoured species have been considered: *Tagetes lemmonii* A. Gray (Compositae) and *Pelargonium odoratum* Hoffmanns 'Lemon' (Geraniaceae). The flowers were harvested and stored in plastic boxes at +4 °C for several days. Phytochemical analyses and the antioxidant activity were performed to verify the change in chemical composition during the post-harvest process. The two species show high total phenolic content and antioxidant activity, up to the 6th day of storage. In *P. odoratum* 'Lemon', total monoterpenes increase considerably during cold storage while sesquiterpenes hydrocarbons decrease. On the other hand, total monoterpenes remain the most abundant class in *T. lemmonii* during storage.

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OC17 - LAVANDIN BY-PRODUCTS DEVELOPMENT IN A CONTEXT OF MULTIFUNCTIONAL AGRICULTURE: A CASE STUDY IN TUSCANY

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Hydrosols obtained during the steam distillation of essential oils have a much softer scent and lower toxicity to mammals than the corresponding essential oils. They increasingly replace water in cosmetics and they are used also in the food factory for their antimicrobial and antioxidant properties [1]. The main product from Lavandin (*Lavandula x hybrida* Balb. ex Ging.) consists in the essential oil obtained from flowering tops, and the corresponding hydrosol has been historically considered a by-product. However, there is an increasing interest in this natural derivative in terms of scientific research and development of commercial products [2].

Following this trend, hydrosols from Lavandin cultivated in a biodynamic farm in Tuscany were obtained. Phytochemical profiles of the hydrosols obtained separately by the flowers and the stems, as well as the essential oil from the flowers, were acquired by GC-MS and ¹H-NMR analyses. Results indicated semi-quantitative differences between the major metabolites including linalool, 1,8-cineole, camphor, linalyl acetate, 4-terpineol, and borneol. Moreover, biological assays were also performed. In particular, germination tests of *Raphanus sativus* L. seeds showed that both Lavandin hydrosols and essential oil obtained from flowers completely inhibited the germination process; repellent activity against *Tribolium confusum* (Coleoptera Tenebrionidae) by the Area Preference Method showed a good repellency for both hydrosols extracts with RD₅₀ values of 3.6 and 3.3 μLcm^{-1} for the flowers and stems, respectively.

Within the farm, the development of further hydrosols from other plant species is in process and a dedicated manufacturing laboratory was implemented, allowing as well the development of specialised educational programs. The overall experience represents a valuable testimonial of multifunctional agriculture and applied research on medicinal and aromatic plants (MAPs), a favourable combination that could be better replicated under the new Italian regulation of this sector (DL 21 May 2018 n. 75).

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**OC18 - ARTEMISIA ANNUA ESSENTIAL OILS LIPOSOMES:
OPTIMIZATION AND *IN VITRO* ANTIFUNGAL ACTIVITY EVALUATION
AGAINST CANDIDA SPECIES**

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Essential oils (EOs) have been widely used for their antimicrobial and antifungal properties but their instability to light and high volatility can limit the clinical practice¹. A useful strategy to improve their biopharmaceutical properties is represented by drug delivery systems. Aim of the present study was to formulate, optimize and evaluate vesicles loaded by *Artemisia annua* L. (Asteraceae) essential oil (AEO). The inflorescence of *A. annua* were collected in November and hydro-distilled in a Clevenger like apparatus. GC-MS analyses of the resulting EO revealed that his main constituents were camphor (22.6%), artemisia ketone (17.3%) and 1,8-cineole (15.8%). Phosphatidylcholine and cholesterol liposomes loaded with 100 $\mu\text{L}/\text{mL}$ of EO were optimized for their size, polydispersity index (PDI), ζ -potential and morphology. The recovery, encapsulation efficiency (EE%) and release properties were evaluated both for PBS liposomes both for the one made using RPMI-MOPS medium. On this last type of vesicle were performed the antifungal assay on *Candida* species². Results showed that the vesicles exhibit spherical shape, average sizes about 250 nm, the ζ potential about -10 mV, the PDI was about 0.21, EE% were around 75% while the recovery were over 90%. The drug release study showed that after 14 hours almost 100% EO was released from the vesicles. Quantitative analysis were carried out using a HPLC1100-DAD. Liposomes were physically and chemically stable over one month period if stored at 4°C. The minimum fungicidal concentrations (MFCs) of AEO and EO-loaded liposomes was performed against 10 fungal strains of *Candida*. Positive control was made by amphotericin B. The MFC values ranged from 9.8 to 42 $\mu\text{L}/\text{mL}$ of EO and from 5 to 10 $\mu\text{L}/\text{mL}$ of EO-load in liposomes. Among the *Candida* species tested, the most susceptible to EO was *C. norvegensis* (6.25 $\mu\text{L}/\text{mL}$), followed by *C. albicans* ATCC 10231 and *C. krusei* ATCC 6258 while the most susceptible specie to EO-loaded liposomes was *C. norvegensis* (5.00 $\mu\text{L}/\text{mL}$), followed by *C. krusei* from our collection. Statistic was made by t student test. Significant difference was expressed as $p < 0.01$. The findings suggest that EO-loaded liposome proved to be more effective against *Candida* species than the free essential oil. The findings suggest that these formulations can decrease the volatility of EOs, optimize their biological properties and defeat antifungal infections.

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OC19 - DOMESTICATING WILD SPECIES FOR EDIBLE FLOWERS PRODUCTION

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The interest towards edible flowers is currently increasing either as food flavouring and garnish, and as nutraceutical and functional ingredients, due to their phytochemical content with remarkable antioxidant activity. According to the literature¹ and local traditions, several wild species of the Western Italian Alps might have the potential to be exploited in this new developing food sector, which is the topic of the Interreg Alcotra Fr-It 2014-2020 ANTEA project. To evaluate the possibility of domesticating wild species for edible flowers production, the seeds of ten species (*Allium schoenoprasum* L., *A. sphaerocephalon* L., *A. ursinum* L., *Dianthus carthusianorum* L., *D. pavonius* Tausch, *Lavandula angustifolia* Mill., *Primula veris* L., *P. vulgaris* Huds., *Trifolium alpinum* L., *Viola calcarata* L.) were collected in the wild along the Western Italian Alps. Seeds were preserved at 4°C until the seeding, which was performed in a lowland nursery. The germination percentage was recorded, plant growth and the flowering traits and flower yield were monitored during cultivation. These parameters allowed to identify the species more prone to domestication.

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OC20 - COMPARATIVE ANALYSES OF DIFFERENT EXTRACTION PROCEDURES OF ITALIAN PROPOLIS BY HPLC-PDA/UV-ESI-MS/MS AND EVALUATION OF *IN VIVO* ANTI-INFLAMMATORY ACTIVITY

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Propolis, also known as bee glue, is a resinous and sticky material produced by the honeybees (*Apis mellifera* L.) from secretions of several plant species, that are transformed with salivary enzymes and mixed with beeswax to be used by bees in the hive to seal the holes, smooth the internal walls and defend against external invaders, exerting in the same time its antibacterial activity within the hive [1]. Propolis has been used in folk medicine since ancient times as natural remedy due to its antimicrobial and anti-inflammatory properties and recently widely used in preventing several diseases and as health-promoting substance. Several biological and pharmacological studies reported propolis as an antioxidant, antimicrobial, anti-parasite, anti-inflammatory, anti-tumour, hepatoprotective, immunomodulatory, and wound healing agent [2]. Propolis is known to possess a very complex chemical composition influenced by its botanical origin and geographic region [3], with phenolic compounds, such as flavonoids, phenolic acids and esters, as major constituents [4].

In this research, the chemical profiles of six different hydroethanolic propolis extracts originating from several Italian regions, obtained by different extraction methods (static and dynamic macerations, ultrasound and microwave assisted extractions, and Naviglio Extractor[®]), were compared by HPLC-PDA/UV-ESI-MS/MS analysis. Furthermore, one of the propolis extracts was evaluated for its potential as therapeutic agent on inflammation diseases *in vivo*. Results showed that ultrasound microwave assisted extraction was the most efficient (3.3 g dry extract from 5 g of propolis/50 mL of solvent). Quali-quantitative analyses confirmed that propolis is a very complex mixture of phenolic derivatives with chrysin, chrysin methyl ether, and quercetin dimethyl ether as major components and most represented in the ultrasound assisted extract. Between caffeic acid derivatives, caffeic acid phenethyl ester, known for its anti-inflammatory and immunomodulatory actions [5], was detected in all extracts.

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**OC21 - MELISSA OFFICINALIS ESSENTIAL OIL LOADING-
GLYCEROSOMES FOR THE TOPICAL APPLIANCE AGAINST
HERPES LABIALIS (HSV-1)**

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Essential oils (EOs) are complex mixture of strongly active compounds, but very volatile and sensitive to light, oxygen, moisture and temperature. Loading inside nanostructures can be a strategy to stabilize and use them in therapy¹. In the present study, *Melissa officinalis* L. (Lamiaceae) essential oil was loaded inside glycerosomes (GS) at the concentration of 10 µL/mL in order to increase its stability and anti-herpetic activity². GS were prepared by the thin layer evaporation method, using a glycerol/water mixture. The obtained formulation was characterized by Light Scattering (LS) techniques in order to evaluate average diameter (about 60 nm), polydispersity index (≈ 0.2) and ζ -potential (≈ -30 mV), as well as by HPLC-DAD to determine the encapsulation efficiency (EE) of EO inside the GS in terms of citral and β -caryophyllene (≈ 63 % and ≈ 76 % respectively). The same instruments and analytical techniques were adopted to monitor the long-term stability of GS until 4 months and no relevant changes were observed in the chemical-physical parameters. Moreover, GS demonstrated to preserve the EO chemical stability, since the concentrations of citral and β -caryophyllene remained unchanged over time. The morphological observation of GS by transmission electron microscope showed vesicles with several lamellae, spherical shape and small size, confirming the LS analysis. Successively, the obtained GS were tested by *in vitro* antiviral assay against HSV-1/strain vCLIDA61. From these studies, the antiviral activity of EO loaded inside GS resulted higher in comparison with the activity of free EO. Hereby, GS seem to be a good tool to stabilize the EO and also to replace the conventional anti-herpetic drugs, when drug-resistance forms take place.

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P01 - *CALLUNA VULGARIS* (L.) HULL: CHEMICAL INVESTIGATIONS AND ANTIOXIDANT AND ANTIRADICALIC EFFECTIVENESS ON HUMAN KERATINOCYTES

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Calluna vulgaris (L.) Hull. (Ericaceae) is a perennial shrub common in Italy and in many European countries, found both in plains and in hilly and mountain areas. In ethnobotany and in traditional medicine, *C. vulgaris* aerial parts decoction is used for urinary complaints and as antimicrobial¹. More recently, studies on photo-protective activity of water and ethanolic extracts of East European *C. vulgaris* were published²⁻³. Combining enzymatic, colorimetric and HPLC-DAD-MS methods, we analyzed and compared a water extract of *C. vulgaris* collected in Tuscany and a commercially available sample of European dried aerial parts of the species. Following the most recent literature, we investigated antioxidant and antiradicalic activity of *C. vulgaris* extracts by mean of *in vitro* techniques and focusing tests on human keratinocytes.

C. vulgaris collected in Tuscany and the commercially available sample were found to have similar phytochemical characteristics: the water extracts were found to contain mainly polysaccharides, over 15% w/w. Also polyphenols were found to be abundant, about 10% w/w, mainly consisting in condensed flavan-3-ols. Phenolic acids, chromen-4-one derivatives, hydroxycinnamic acids and flavonols were other representative subclasses and chlorogenic acid and hyperoside the most abundant single constituents.

C. vulgaris water extracts exhibited a very strong effect in decreasing ROS levels in H₂O₂ stimulated cells at 100 and 10 µg/ml, with a direct antiradicalic mechanism that not involves the modulation of superoxide-dismutase (SOD) activity. The IC₅₀ of the extract in the DPPH test was below 50 µg/ml. An irreversible oxidative process below 550 mV was observed in cyclic voltammetry measurements.

These preliminary investigations suggest that the water extracts of *C. vulgaris*, due to the high content of polyphenols, have strong antioxidant and antiradicalic properties, worth to be considered in the modern phytotherapy in particular as an innovative skin photo-protective agent.

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P02 - UHPLC-HRMS/MS METABOLIC PROFILING OF ZUCCHINI CV. 'LUNGO FIORENTINO' WASTES FOR THEIR NUTRA- AND COSMECEUTICAL VALORIZATION

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Large wastes' amounts are produced every day at early stages of the agri-food chain¹. Recovering these waste materials is mandatory not only for reducing its environmental impact, and disposal costs, but also for converting them into highly qualified products. In this context, faulty zucchini fruits (*Cucurbita pepo* L. cv. 'Lungo Fiorentino', Cucurbitaceae), intended for disposal, were rescued as effective, inexpensive and bio-sustainable source for cosmeceutical purposes. The waste material underwent ultrasound assisted maceration to obtain ZLF-O (Zucchini 'Lungo Fiorentino' - Organic) and ZLF-A (Zucchini 'Lungo Fiorentino' - Alcoholic) extracts². These latter were chemically profiled by UHPLC-HRMS/MS techniques. Flavonol and flavone compounds were the main constituents of ZLF-A extract, which showed a strong antiradical activity vs. DPPH radical and ABTS radical cation. Based on MTT data, which unravel that ZLF-A did not exert cytotoxicity at doses up to 200 µg/mL, its incorporation into a base cream formula was investigated. Zucchini-based emulsion was screened for its antiradical properties, and cytotoxic effects towards human keratinocytes and fibroblasts. The efficacy and safety of ZLF-A-enriched cream was further tested on reconstructed epidermis disks (EpiskinTM), whereas its chemical stability was assessed over time, considering different storage conditions. Data acquired were eager to convey a suitable reuse of zucchini waste, in which the nutraceutical zucchini value was further exploited for its cosmeceutical strength.

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P03 - SILYMARIN NANOSTRUCTURED LIPID CARRIERS TO IMPROVE ITS BIOPHARMACEUTICAL PROPERTIES AND IN VIVO EFFICACY IN TYPE 2 DIABETES

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Silymarin (SLM) is the main constituent of the extract from fruits and seeds of *Silybum marianum* L. Gaertn. (Asteraceae) and has been used for decades as hepatoprotectant. Recently it has been proposed to be beneficial in type 2 diabetes patients¹. However, silymarin is a poorly water-soluble drug with limited oral bioavailability. In this work, nanostructured lipid carriers (NLC) with two different lipid combinations were prepared. Stearic acid: Capryol 90 (NLC-SA) and cetyl palmitate:Lauroglycol 90 (NLC-CP) were selected as lipid mixtures. Brij S20 was used as surfactant. The optimized formulations showed particle size < 300 nm, polydispersity index (PDI) < 0.30 and zeta potential > 30 mV. Fluorescent formulations were also developed employing fluorescein isothiocyanate (FITC) as model drug. Surface morphology was determined by TEM. NLC showed high encapsulation efficiencies (EE%). No degradation phenomena were observed in simulated gastrointestinal fluids. Storage stability of suspensions and lyophilized products was also investigated. About 60% of SLM was released in 24 h in PBS pH 7.4. In vitro permeation experiments with artificial membranes and Caco-2 cells revealed that both NLC enhanced the permeation of entrapped compound. Cellular uptake studies indicated that active processes are involved in the internalization of developed formulations. In order to evaluate the safety of the NLC and to choose the best formulation to enhance the pharmacological potential of SLM, in vivo experiments were performed in a metabolic syndrome and diabetes mouse model induced with High Fat Diet (HFD) and streptozotocin (STZ)². These studies indicated that the treatment with SLM-NLC-SA exhibited a significant down-regulation of blood glucose levels compared to the groups treated with free SLM by the first week of the study period. Besides, SLMNLC-SA reduce triglycerides levels significantly in comparison to free SLM. Furthermore, the liver-carbonylated proteins were measured as integrated density from western blot membranes. The repeated treatment with SLM-NLC-SA was able to restore the oxidative damage induced by HFD + STZ to the levels of the control group. Finally, histopathological investigations revealed no agglomeration of lymphocytes around the hepatocytes and a less cellular vacuolation in the HFD + STZ + SLM-NLC-SA treated animals.

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P04 - INTERREG B-ICE PROJECT: PRESENTATION OF THE ETHNOBOTANIC SURVEY IN VALMALENCO

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Within the Interreg Project Italy-Switzerland *Bernina Terra Glacialis. Study and enhancement of a precious natural and cultural heritage in an open Alpin region, with innovative approaches to the future*, it is planned to carry out an ethnobotanical investigation aimed at the study and enhancement of the plant and cultural biodiversity in Valmalenco (SO). The three-year project started in December 2018 and aimed to create a management model for the ongoing climate change.

In this context, a precious heritage is represented by spontaneous plants. In the past, these species were used for human and animal health care, in the food sector, in cosmetics, for ritual purposes and manufacturing. This heritage of knowledge represents an important source for the local enhancement. Therefore, the project's goal is to conduct an ethnobotanical research in the Unione dei Comuni della Valmalenco (Chiesa in Valmalenco, Caspoggio, Lanzada, Spriana, Torre di Santa Maria).

The investigation involves the proposal of dedicated interviews to the local population, with special attention to the intergenerational comparison about the traditional uses of plant species. The research program is going to be based on a dual study approach, anthropocentric and phytocentric, and it is going to be organised in three phases: 1st year) census of the local flora, interviews and elaboration of the collected data; 2nd year) comparison of these information with scientific literature in order to validate or disprove the traditional uses and to highlight relevant local uses characteristics, with the subsequent selection of species of interest; 3rd year) creation of places for the transmission of the intergenerational knowledge, in which learned information will be useful to generate new involvement perspectives.

Among the species of interest, we are going to select some target species in order to: a) cultivate some of them; b) realize a Botanic Garden with an educational-informative value in Sant'Antonio di Caspoggio; c) support the creation of shared Gardens in residential areas and individual homes.

Return results by organizing different types of events will allow the local population to reach a wide knowledge concerning the native plant heritage and its potential for use. In this way, a greater awareness of the Valley's cultural value will be assured, affecting positively the attractiveness of the territory and promoting a new form of tourism.

P05 - CROPPING A NATURAL POPULATION OF *Rosmarinus officinalis* L. FROM N.W. SARDINIA. MORPHO-PHENOLOGIC VARIABILITY AND BIOLOGICAL ACTIVITY OF ESSENTIAL OIL

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In addition to its uses in pharmaceuticals, perfumes, and cosmetics, rosemary's multiple biological activities may be applied to preserve foodstuffs and reduce the risks of foodborne diseases¹.

The black *Aspergillus* group, in particular *Aspergillus carbonarius* (Bain.) Thom, is a common Mediterranean contaminant, especially of fruit. This fungus, besides being a contaminant, can also produce ochratoxin A (OTA), a highly toxic fungal secondary metabolite². Therefore, fungal growth control is very important for the safeguarding of both plant production and human health.

We tested the effect of rosemary essential oil (e.o.) on the inhibition of *A. carbonarius* growth in a conducive liquid medium. Rosemary cuttings from a rosemary natural population in Alghero (NW Sardinia) were transplanted in an experimental field in Castelsardo-Lu Bagnu (NW Sardinia) in May 2017. Morpho-phenological data were collected on plants and the e.o. was extracted by steam distillation and used for a biological activity assay against *A. carbonarius*. The e.o. chemical profile was also determined by GC-MS. Variability of both morphological traits and of phenology were observed within the rosemary population, and two plant types were identified, one of which produced a higher number of flowers and had a longer flowering season. The main components of e.o. were α -pinene, eucalyptol and camphene for one type and α -pinene, caryophyllene and camphene for the other. The rosemary e.o. significantly inhibited growth of *A. carbonarius*. This result should encourage verification of this oil's other biological activities, such as its effect on OTA biosynthesis by the same fungus.

This study was developed in collaboration with the Temporary Reception Center for migrants and asylum seekers (CAS) of Baja Sunajola run by the Social Cooperative La Luna in Lu Bagnu-Castelsardo, in the frame of a training project about medicinal and aromatic plants cultivation for essential oil production.

Acknowledgment

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P06 - NMR PROFILING, QUALITATIVE AND BIOAGRONOMICAL ANALYSIS OF POMEGRANATE (*Punica granatum* L.) FRUITS

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Pomegranate (*Punica granatum* L., family Lythraceae) is one of the oldest known edible fruit tree, originating in Central Asia, but now cultivated around the world¹. Pomegranates are rich in aril, the percentage of which ranges from 50 to 70% of total fruit, while pomegranate peels (exocarp and mesocarp), comprising almost 26–30% of total fruit weight².

The aim of this study is to evaluate the bio-agronomical and qualitative characteristics as well as the phytochemical properties of pomegranate juice of aril and mesocarp (also known as albedo) extract one the most abundant by-product obtained in large quantities after the juice production.

To this purpose pomegranate fruits of four accessions, belonging to the Campania germplasm (San Pietro, CREA-FRC3, CREA-FRC7, DISTABIF1), as well as three standard cultivars (Acco, Wonderful, Dente di Cavallo) have been investigated.

The metabolic profiling of the aril juice and the albedo crude extract, carried out by NMR-based metabolomic approach, allowed the identification of the most abundant primary and secondary metabolites.

Moreover, the secondary metabolites present in the albedo extract and pomegranate juice have been isolated by chromatographic techniques and characterized by spectroscopic 1D and 2D NMR techniques³.

The bio-agronomical and the qualitative analysis highlighted a high variability both in accessions and in standard cultivars, in terms of weight and colour of fruits and in terms of phytochemical contents.

Total polyphenols, anthocyanins and flavonoids contents, as well as the radical scavenging activity have been evaluated for pomegranate juices of aril and albedo extracts. These latter were very rich in phenols suggesting their potential source of bioactive compounds.

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P07 - IN DEPTH LC-ESIMSⁿ-GUIDED PHYTOCHEMICAL ANALYSIS OF *ZIZIPHUS JUJUBA* MILL. LEAVES

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Ziziphus jujuba Mill. (syn. *Z. sativa* Gaertner, *Z. vulgaris* Lam.), belonging to the family Rhamnaceae¹, is a thorny small or medium sized tree widely cultivated in Italy for its edible orange-brown fruits, commonly known as “giuggiole” or “zizzole”².

The leaves for centuries have been harvested and dried to prepare bedtime infusions, able to exert beneficial effects for both the heart and the nervous system³. *Z. jujuba* leaf tea is a product which has recently gained a great deal of attention in China⁴. Most studies on the bioactivity and active components of *Z. jujuba* focused on the seeds and fruits; less attention has been devoted to the leaves of *Z. jujuba*.

With the aim to obtain a comprehensive analysis of the specialised metabolites occurring in the leaves of *Z. jujuba*, a LC-ESI/(HR)Orbitrap/MS profile in negative ion mode of the methanol extract was carried out. The LC-MS profile guided the isolation of 42 compounds, of which the structures were elucidated by 1D and 2D-NMR experiments. Based on this approach, 2 previously unreported dammarane-type saponins have been characterized along with flavonoid derivatives, dammarane-type saponins and triterpenic acids. Dammarane-type saponins were tested for their antiproliferative activity against A549 and HeLa cancer cell lines. None of the tested compounds, in a range of concentrations between 12.5 and 100 μ M, caused a significant reduction of the cell number. This work provides a deep insight on the chemistry of the leaves of *Z. jujuba* and could be useful for further biological studies aimed at identifying phytochemicals contributing to the health benefits attributed to this herbal drug.

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**P08 - CHEMICAL COMPOSITION OF BIOACTIVE COMPOUNDS IN
PRUNUS DOMESTICA L. WASTE PRODUCT**

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Since a long time, plants had important roles in the maintaining of human health, either as components in medicines or as food sources¹. The European plum (*Prunus domestica* L.) is one of the first domesticated fruits by humans. It belongs to the genus *Prunus* of the family Rosaceae that includes also apple, cherry, pear, peach, and several berry crops². Its fruits could be consumed fresh, dried or prepared as jams, compotes and preserves³. They are well-known as respectable source of nutrients, as well as for their antioxidant, antimicrobial and anticancer activities, due to the presence of many bioactive compounds such as carbohydrates, soluble fibers (pectins), organic acids, tannins, polyphenols, flavonoids, and vitamins³. In the light of all the above, the aim of the present study is to characterize bioactive compounds present in waste juice from dried fruit production. For that, phenolic compounds were isolated with 80% aqueous ethanol and then analysed by colorimetric assays, HPLC-UV/DAD, ESI-MS, and MS2. Thus, the six samples contained important amounts of phenolic compounds (from 2.70 to 4.07 mg GAE/g) and flavonoid (from 0.023 to 0.125 mg QE/g). In addition, the analysis of the ethanolic extract by ESI-MS and MS2 revealed that the most present compounds are caffeoylquinic acid isomers (5'-caffeoylquinic acid and 3'-caffeoylquinic acid), cyanidin (-3-O-glucoside and -3-O-galactoside) and quercetin (rhamnoside and deoxyhexoside). The results therefore show that by-product of *Prunus domestica* appropriately formulated could be used as a nutraceutical derivative for its bioactive content and its beneficial properties on the intestine due to the high sorbitol content.

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P09 - ESSENTIAL OIL ANALYSIS AND STUDY OF THE ANTIOXIDANT ACTIVITY OF CULTIVATED OREGANO

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The aim of this thesis was to study the various data concerning the growth of cultivated plants of *Origanum vulgare* L. ssp. *hirtum* (Link) Letsw (Lamiaceae). The study was focused mainly on the qualitative and quantitative characteristics of the essential oil obtained by distillation of the aerial parts and whether these characteristics are affected by the soil composition, the time of collection of the plant material and the application of two foliar fertilizer formulations to plants. The experimental plan was based on a latin square 3x3 and the statistical analysis of data was done using the ANOVA method with the SPSS 15.0 program. The volatile components were obtained by hydrodistillation and the quality and quantity control took place in a gas chromatography mass spectrometry (GC-MS). Finally, the antioxidant activity of the cultivated oregano was studied via the interaction of the samples with the stable free radical 1,1- diphenyl- 2- picrylhydrazyl (DPPH). The results of the study show that only the time of collection and not the application of various formulations to plants was statistically significant. Another interesting conclusion was that high temperature and water deficiency can induce an increase in essential oil content and thus result in higher qualitative characteristics. As far as the antioxidant activity is concerned, some of the essential oils did not exhibit high radical-scavenging properties as shown in the DPPH assay, especially those of fresh plant material and thus further research is necessary.

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P10 - METABOLOMIC STUDY OF SORGHUM (*S. bicolor*) GROWING ON TWELVE FIELDS IN NORTHERN ITALY

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Global population growth, climate changes and resources exploitation make it urgent to develop sustainable and smart agricultural practices¹. In this framework, an upgraded knowledge of plant-environment interactions is required, and a suitable approach is represented by untargeted metabolomics coupled with agro-climatic studies. This work is focused on *Sorghum bicolor* (L.) Moench, the fifth most important cereal cultivated for food, feed, fiber and fuel². Agricultural assessments and ¹H NMR based-metabolomics analysis were carried out on grain sorghum cultivated on 12 different fields of Emilia-Romagna (Northern Italy). Plant samples were collected at three different stages: seedlings, vegetative and ripeness. Thus, the relationships between agro-climatic parameters and metabolome variations of leaves, stems, and grains were investigated through multivariate data treatment. Moreover, antioxidant activity of grain was also measured by BCB *in vitro* test.

The results of PCA highlighted qualitative and quantitative differences among the metabolomes of the twelve sorghum crops. Dhurrin, 4-OH-benzaldehyde, rutin, sugars, organic acids and amino acids were the most varying metabolites. The content of these metabolites resulted (by OPLS model) affected by water supply and soil features such as clay and organic carbon content. The PLS-DA model provided information on the degree of sorghum development on the basis of leaf metabolome. Moreover, the analysis of seedling metabolome resulted a valuable tool to predict, and eventually prevent, the low grain yield. Metabolomic profiling resulted also useful to detect the potential occurrence of dhurrin in grain, which must be kept at very low content for good quality grain³.

In conclusion, the results obtained in this work encourage the use of 'omic' approach to support and extend agronomic studies. A first data set is also provided, which might be shared and implemented, tackling the need to develop smart agriculture practices.

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**P11 - IRIDOIDS AND PHENYLETHANOIDS FROM *EUPHRASIA*
*ROSTKOVIANA***

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Plants of the genus *Euphrasia* (Orobanchaceae) have proven to be the source of a wide range of specialized metabolites, including the classes of flavonoids, iridoids, phenylethanoids, derivatives of coumaric acid and lipids. Several pharmacological or clinical studies have supported the traditional use of extracts of *Euphrasia* species to relieve ocular inflammation and many diverse biological activities as well. A meticulous separation of components allowed us to identify five iridoids, five phenylethanoids and the flavonoid rutin in addition to three glycosides from an alpine collection of *E. rostkoviana*¹. Moreover, a targeted quantitative analysis revealed that the content of specialized products was highly variable among seven wild populations found in northern Italy. Later, we reported on the flavonoid rutin, one iridoid and two phenylethanoids as acetylated derivatives². All but one of these compounds, revealed to be acetate esters. The previously undescribed phenylethanoid rostkovianoside A had a structure close to crassifolioside but lacking the caffeate ester.

Similar derivatives of verbascoside are well known in the literature and were named: verbascoside (verbascoside lacking the caffeate ester) and cistanoside F (verbascoside lacking the hydroxytyrosol acetal). Verbascoside and cistanoside F are both in the biosynthetic pathway to verbascoside³ or are its degradation products by means of bacterial and enzymatic⁴ or chemical hydrolysis⁵.

We report herein on the identification, in the methanolic extracts of *E. rostkoviana* populations from the Alps and by HR-ESI-MS and NMR methods, of the following compounds: verbascoside, cistanoside F as well as the derivatives of crassifolioside lacking the hydroxytyrosol acetal and of ehrenoside lacking the caffeate ester or the hydroxytyrosol acetal. Moreover, we have submitted verbascoside to several reaction conditions in order to investigate the chemical reactivity of glycosylated phenylethanoids.

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P12 - CAFFEOYLQUINIC ACIDS AND SESQUITERPENE LACTONES ACCUMULATION IN *INULA BRITANNICA* IN VITRO

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Inula britannica L., Asteraceae, is a medicinal plant, known in Traditional Chinese and Kampo medicinal practices. It is applied for phlegm removal in pulmonary ailments, as a tonic and a warming agent. Research has shown the presence of sesquiterpene lactones and flavonoids in aerials of the plant, and provided evidence for the anticancer, anti-inflammatory and neuroprotective potential of different preparations of the plant.

The production of different caffeoylquinic acid (CQA) derivatives, as well as sesquiterpene lactones has been studied in a model system of shoot cultures of the plant. The combined effect of Murashige and Skoog (MS) vs. Gamborg (G5) vitamins with low (0.2 mg/l) and high (0.7 mg/l) concentrations of benzyl adenine (BA) applied alone or in combination with 0.1 mg/l naphthylacetic acid (NAA) were studied. The content of caffeoylquinic acids (CQA) was studied by means of HPLC analysis of the methanol extract and sesquiterpene lactones content was studied by means of GS/MS chromatography of the chloroform extract of the plant material.

Highest CQA production was achieved in MS supplemented media which were plant growth regulators (PGR)-free or where 0.2 mg/l BA was applied alone. In these treatments the slowest growth and lowest morphological changes were observed. Intensive biomass production and callus formation in 0.7 mg/l BA treatment led to the lowest production of these compounds. G5 vitamins were shown to be favorable regarding total sesquiterpene lactone production, as compared with MS ones; however the stimulation of biomass formation by PGR treatments led to lowering of the levels of sesquiterpene lactones regardless of the vitamin supplementation.

The relations between plant growth and morphogenesis and secondary metabolite production in the plant could be used as a tool to affect the biotechnological production of potential phytopharmaceuticals by optimization of its indigenous biosynthetic capacity without the application of genetic transformations.

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P13 - ESTABLISHMENT OF HAIRY ROOT CULTURES OF *SALVIA CORRUGATA* VAHL.

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Salvia corrugata Vahl. is an ornamental plant that produces two icetexane diterpene quinones with significant antibacterial activity^{1,2}. The aim of the study was to obtain transformed roots of this species for the evaluation of their phytochemical profile. Two strains of *Agrobacterium rhizogenes* (wild type ATCC 15834 and hyper virulent LBA 9402) and one of *A. tumefaciens* (GV 3101) were tested for their ability to induce hairy root formation on wounded leaves. The best response (57 %) was achieved by infection with ATCC 15834 *A. rhizogenes* thirty days after the infection onto the hormone-free MS basal solid medium. Two hairy-root clones from ATCC 15834 were established. Transformation was confirmed by polymerase chain reaction analysis of *rol c* and *vir c* genes. The evaluation of growth in TIBs showed a best biomass production of clone FA8 on MS0 with 30 mg/L of sucrose. In comparison to other tested media, MS0 and half WPM, both additioned with 30 mg/L of sucrose, were found to be the best for biomass production. As there were many different factors that can support or interfere with the biomass production a statistical analysis has been performed to correctly define the various roles of the server agents uses. A Principal Component Analysis (PCA) was performed to identify the most important factors to be considered for an optimal growth. The methanolic extracts of the biomass (16.8 g) was fractionated by Si gel MPLC eluting with n-hexane/CHCl₃/CH₃OH at concentrations varying from 100:0:0 to 0:0:100 to obtain 16 fractions. The methanolic extract and the semi-purified fractions were tested against several multidrug resistant clinical strains of various bacterial species (*Staphylococcus aureus* MRSA, *S.epidermidis* MRSE, *Enterococcus faecalis* VRE, *E.faecium* VRE, *Micrococcus luteus*, *E.coli* UTI (i.e. obtained from a human urinary tract infection). The total extract was poorly effective while the semi purified fractions displayed variable potency with MIC values ranging from 8 to >128 µg/mL against the Gram-positive species considered. Fractions 3 and fraction 9 were purified by semi-preparative RP HPLC affording horminone (9.1 mg) and ursolic acid (4.3 mg) respectively. Horminone displayed MIC values ranging from 4 to 64 µg/mL.

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P14 - TRACE ELEMENTS IN EDIBLE FLOWERS FROM LIGURIA: AN EXPLORATORY STUDY

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Recently, the use of edible flowers has become very popular, both in traditional and innovative recipes, and now several floral species can be found not only in the kitchens of famous restaurants but also as packed salads in the supermarkets. The increasing consumer appreciation is due to the sensory properties of several flowers (taste, flavor, shape, color, texture) and to their nutritional value¹, being low in fat and rich in nutrients. While several studies in literature have reported interesting antioxidant, anti-inflammatory and anti-microbial activities for a number of species², data on mineral composition are scarce³. The measure of the concentration of trace elements in edible flowers is important since some elements (e.g. As, Cd, Pb) are toxic even at low concentrations, and some other elements (e.g. Cu, Fe, Mn, Ni, Zn) are essential but they can be toxic or may induce allergic reactions when beyond certain levels. Moreover, there are hundreds of plant species which are known to be hyperaccumulators of metals and metalloids, but data are referred to aboveground biomass and never specifically to floral parts^{4,5}. The present study is part of the INTERREG-ALCOLTRA project “ANTEA” (<http://www.interregantea.eu/>), aimed to increase the supply chain of edible flowers cultivated in Liguria (Italy) and PACA (France), mainly belonging to Asteraceae and Lamiaceae. The determination of the mineral composition and the highlighting of hyperaccumulator species, if any, was included in the toxicity checks. Petals of edible flowers (n=19) grown in West Liguria in controlled conditions in open grounds were freeze dried, grinded and analyzed. The concentrations of 10 trace elements (Cd, Co, Cu, Fe, Mn, Ni, Pb, Sr, V, Zn) were measured using atomic emission spectrometry with inductively coupled plasma source (ICP-OES). One sample, *Acmella oleracea* (L.) R.K. Jansen, Asteraceae, was considered as an outlier, showing Mn concentrations 15-fold higher than the mean value of the other samples. Regarding the remaining samples, PCA (Principal Component Analysis) allowed to separate the two families on the basis of the concentrations of Cd, Fe, Mn, V, resulting significantly higher in flowers of Asteraceae. Anyway, none of the studied samples showed health risk for consumers. Research is in progress on a larger set of samples in order to determine the mineral composition of the increasing number of edible floral species in use.

Acknowledgement. The EU INTERREG ALCOTRA Project n°11039 “ANTEA” is kindly acknowledged

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P15 - FRUIT OF *ABELMOSCHUS ESCULENTUS* L. MOENCH: A RICH SOURCE OF POLAR LIPID AND PHENOLIC DERIVATIVES

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Okra (*Abelmoschus esculentus* L. Moench.), a vegetable crop, belonging to Malvaceae family, is very popular in North-eastern African countries for its edible fruit. It is also an important medicinal plant of tropical and subtropical India and it has been used since time in the Ayurveda, Siddha and Unani medicines¹. Okra fruits are commonly used as principal ingredient in several dish of North-eastern African cuisine. Nowadays, this species is widespread and it can be easily found in European local markets. Although the extensive and spread use of this vegetable, there is no comprehensive literature information on the polar lipids occurring in the oil of okra seeds and on the secondary metabolites occurring in the fruit. In this study, a phytochemical investigation of the hydroalcoholic extract of okra fruits by high-performance liquid chromatography coupled to multiple-stage linear ion-trap and orbitrap high-resolution mass spectrometry using negative electrospray ionization mode (LC-ESI/LTQOrbitrap/MS/MSⁿ) was carried out. Polar lipid classes, as oxylipins, phospholipids, glycolipids and cerebrosides, were tentatively identified by this analytical approach. Moreover, the LC-ESI/LTQOrbitrap/MS profile and LC-ESI/LTQOrbitrap/MS/MS experiments guided the isolation of 22 compounds mainly belonging to phenolic acids, fenypropanoid and flavonoid classes, whose structures were elucidated by 1D- and 2D-NMR experiments.

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P16 - INHIBITORY EFFECT OF *WASHINGTONIA FILIFERA* EXTRACTS ON CHOLINESTERASES ACTIVITIES

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The aim of the present study was to investigate the effect of *Washingtonia filifera* Lindl. H.Wendl. (Arecaceae) extracts on acetylcholinesterase (AChE) and butyrylcholinesterase (BChE) activities.

The fruits of *Washingtonia filifera*, collected in Tunisia in the areas of Gabès and Sousse, were extracted (pulp and seed, separately) with different solvents: water, ethanol and methanol.

The results showed that the extracts obtained from the pulp were not effective inhibitors on cholinesterases activities, while the extracts from the seeds had significant inhibitory effects on both enzymes. In particular, seeds extracts exhibited a better inhibitory activity against BChE than against AChE. The ethanolic extracts from seeds collected in the region of Gabès showed the highest BChE inhibitory activity, comparable to that of the standard drug galantamine.

Since cholinesterases inhibitors are implicated in Alzheimer's disease treatment¹, *Washingtonia filifera* seems to be a good source of natural bioactive compounds which could be useful for pharmaceutical application.

The present study will continue in order to isolate the single active components responsible for these enzyme inhibitory activities.

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P17 - PHYTOCHEMICAL, BIOCHEMICAL AND MORPHOLOGICAL CHARACTERIZATION OF *PHASEOLUS VULGARIS* SUBSP. *VULGARIS* 'LENZARIELLO' LANDRACE, CULTIVATED ON FARM IN MARGINAL AREAS OF THE CAMPANIA REGION

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Current nutritional recommendations have increased the value of legumes as healthy source of proteins, and even more so for those food products with particular characteristics and qualities derived from their geographical origin.

Phaseolus vulgaris L. subsp. *vulgaris* (Fabaceae) is one of the most cultivated species as it represents one of the greatest sources of vegetable proteins in the human diet. It was introduced in the early 1500s in Europe, where it underwent a long selection and diversification process which produced a very high number of cultivars¹. This high variability often generates taxonomic and nomenclatural uncertainties in the determinations of the different cultivars. Indeed, in Italy, as in several other countries, there are a number of locally adapted landraces, many of which are at extinction risk.

Thus, the assessment of the existing diversity, not only between but also within landraces, is a basic knowledge for conservation and exploitation program of agricultural biodiversity and food quality.

In this context, we carried out morphological, biochemical and phytochemical studies to characterize a local landrace *P. vulgaris* L. subsp *vulgaris* "Lenzariello". It is a widespread entity in the north of Caserta (Campania, Southern Italy), whose epithet "Lenzariello" derives from "lenza", a term commonly used to indicate a small portion of terraced land.

The morphometric study was carried out on 34 qualitative and quantitative characters selected according to the "Descriptor for *Phaseolus vulgaris*"². The seed chemical composition was investigated, analyzing separately integument and endosperm, in terms of its primary and secondary metabolites through an integrated approach employing NMR and HRMS tools.

Data acquired were analyzed by simple and multivariate statistical methods in order to evaluate variability and effective autonomy of this cultivar as well as its nutritional value.

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**P18 - PHYTOCHEMICAL AND PHARMACOLOGICAL PROFILES OF
ANTHEMIS TINCTORIA VAR. *PALLIDA* AND *A. CRETICA* SUBSP.
*TENUILOBA***

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Members of *Anthemis* genus are extensively used in the Turkish folk medicine to treat various ailments. In this present study, the ethyl acetate, methanolic and aqueous extracts of aerial the parts of *Anthemis tinctoria* var. *pallida* (ATP) and *A. cretica* subsp. *tenuiloba* (ACT) growing in Turkey were investigated for their antioxidant and key enzyme inhibitory potentials. Total phenolic and flavonoid contents were determined using colorimetric methods.

The antioxidant capacities of the studied extracts were evaluated using different assays including free radical scavenging, reducing power, phosphomolybdenum, and metal chelating. Additionally, we evaluated the putative protective effects of *Anthemis* extracts on "Cortical Spreading Depression" (CSD) paradigm, on rat cortex specimens treated with an excitotoxicity stimulus. To this regard, we assayed extract capability in blunting CSD-induced cortex 5-HT decrease. All the extracts showed strong antioxidant abilities, with the best activity exerted by MeOH extracts. Enzyme inhibition was tested on AChE, BChE, α -amylase, α -glucosidase, and tyrosinase. Only the EtOAc and MeOH extracts were potent against AChE and BChE. The extracts showed remarkable enzyme inhibitory effects against tyrosinase and α -glucosidase, and modest activity against α -amylase. Finally, in agreement with the evaluation of antioxidant activity, *Anthemis* MeOH extracts revealed the most effective in restoring physiological 5-HT level, in cortex specimens subjected to an excitotoxic stimulus.

The results highlighted the biological potential of the studied *Anthemis* species and warrant for further studies to explore their potential use in phytomedicine and cosmetics.

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P19 - EVALUATION OF BIOLOGICAL ACTIVITIES AND CHEMICAL COMPOSITION OF *WASHINGTONIA FILIFERA* SEEDS

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Seeds of *Washingtonia filifera* Lindl. H.Wendl. (Arecaceae) fruits collected in two areas of Tunisia (Gabés and Sousse) were analysed for their fatty acid and phenolic composition and their antioxidant activity and xanthine oxidase (XO) capacities. Seed extracts revealed as a good source of polyphenols, namely flavonoids, and also showed significant antioxidant activity. The phenolic profile mainly consisted of proanthocyanidins, being procyanidin dimers B1-B4 the majority compounds. Minor amounts of some sulphated flavonols were also detected. Seed alcoholic extracts also displayed interesting XO inhibitory activity. Procyanidin B1, a majority component in the extracts, could be an important contributor to that activity, as it was found to possess good XO inhibition capacity. Docking studies were also performed to predict the binding sites of procyanidins B1 and B2 within XO structure.

**P20 - PRUNUS AMERICANA MARSH. GROWN IN CENTRAL ITALY:
EVALUATION OF TOTAL POLYPHENOLS CONTENT AND *IN VITRO*
ANTIOXIDANT ACTIVITIES**

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Prunus americana Marsh. (Rosaceae) commonly called American plum, is a Missouri native, small, deciduous, single trunk tree or multi-stemmed shrub which grows in rocky or sandy soils in woodlands, pastures, streams and hedgerows throughout the State¹. The small white flowers with five petals occur singly or in umbels in the leaf axils. Fruits are yellow or red drupes 2.0 to 3.2 cm in diameter. They may be solitary or in clusters. The seed is smooth and compressed². The American plum is used for both ornamental and culinary purposes. The fruit is eaten fresh and is made into jellies, jam and wine³. Data in the literature indicate that *P. americana* fruits represent a valid source of polyphenolic compounds with antioxidant activity. However, these studies refer to the fruits of plants grown spontaneously or cultivated in North America^{4,6}, while there are no results on plants grown in other countries. The aim of this work was to evaluate the antioxidant properties and the polyphenol content of fruits harvested from *P. americana* plants naturalized in the Marche region at 550 m above sea level in three different stages of fruit ripening. The polyphenols content and the antioxidant activity was evaluated utilizing the methods previously described^{7,8}. Polyphenolic content results show that the concentration increases in the whole fruit during ripening while in the pulp it remained almost constant. Scavenging activity from pulp show an EC₅₀ value of 0,22 mg fresh weight mL⁻¹. In whole fruits the scavenging activity increases with the degree of ripening up to EC₅₀ value of 0.11 mg of fresh weight mL⁻¹. Also the ORAC assay shows a good antioxidant activity and the highest ORAC value was obtained with the extract of whole fruits with a value equal to 15.49 equivalents of Trolox g⁻¹ of fresh weight. Over 70% of the activity was detected in the pulp. Lastly, the ability of our extracts to inhibit the lipid peroxidation process was evaluated. The best results were obtained with the complete ripened whole fruit extract with an IC₅₀ value corresponding to 17 mg fresh weight mL⁻¹. This research suggest that also *P. americana* fruits growing in our region could represent a potential source of natural antioxidants and could be used as a dietary supplements. The phytochemical evaluation of all the plant extracts is still in progress.

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P21 - STABILITY AND BIOACCESSIBILITY OF *CANNABIS SATIVA* L. EXTRACTS UNDER *IN VITRO* SIMULATED GASTROINTESTINAL DIGESTION

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The interest in *Cannabis sativa* L. (Cannabaceae) phytocomplex as a medicinal tool is a recently-emerging topic. Δ^9 -tetrahydrocannabinol (THC), the major psychotropic constituent, has been characterized for its analgesic, antispasmodic and antiemetic activity. Cannabidiol (CBD), the major non-psychotropic constituent, instead, has elicited interest for its potential therapeutic use in a number of diseases associated to inflammatory conditions¹.

Despite the growing scientific interest, only one standardized extract with a fixed THC:CBD ratio (1:1) has been registered so far. In Italy, the herbal substance can be dispensed and should be administered by vaporization, as an herbal tea or as an oil extract². However, information on the pharmacodynamics and pharmacokinetics of this preparations are lacking.

In this study we evaluated the stability and bioaccessibility of different non-psychotropic *C. sativa* varieties (THC < 0.6%), under *in vitro* simulated gastrointestinal digestion.

Dried *C. sativa* inflorescences with different CBD content were extracted using water, ethanol and olive oil, with or without heat decarboxylation of cannabinoids and the main cannabinoids content was analyzed by HPLC-DAD. Samples were then subjected to simulated gastric and intestinal digestion and the “serum-available” fraction was separated from the “colon-available” fraction using cellulose dialysis tubes. The percentage recovery of cannabinoids was evaluated after gastric and intestinal digestion by HPLC-DAD³.

Notably, we found that the overall gastrointestinal stability and bioaccessibility were strongly influenced by the extraction solvent used. Thus, our study demonstrated the need to standardize cannabis preparations not only to obtain the maximum yield of constituents, but also taking into account the effect of the extraction matrix on their gastrointestinal digestion.

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**P22 - “GRANO SIBERIANO VALTELLINESE”: A LITTLE KNOWN
LANDRACE OF *FAGOPYRUM TATARICUM* (L.) GAERTN. RICH IN RUTIN**

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Conservation and valorization of landraces are topics of great interest since many are endangered genetic resources that could be useful not only in crop improvement plans but also to support the economy of territories where they are (or were) traditionally cultivated. This research analyzed the characteristics of a littleknown landrace of *Fagopyrum tataricum* (L.) Gaertn (Polygonaceae) ("Grano Siberiano Valtellinese") introduced at the end of the 18th century in the mountain areas of Valtellina, a valley in the Northern Italy, and which has now almost disappeared¹. Agronomical, ecological (functional strategy of Grime) and phytochemical (rutin, quercetin and fagopyrin content) analysis were carried out in order to characterize this landrace and compare it with other genotypes of *F. tataricum* and *F. esculentum*. Experimental fields set up in the study areas showed that "Grano Siberiano Valtellinese" is the best adapted genotype to the environmental conditions of Valtellina valley, where it developed taller plants with a high number of flowers. Furthermore, it was found to be the most tolerant to stress (functional strategy: CS/CSR). Phytochemical analysis showed that this genotype, compared to other local landraces of *F. esculentum*, has a higher concentration of rutin in the seeds (764 ± 39 ug/g) and in the shoots (370 ± 66 ug/g) which make it interesting for the production of nutraceutical foods. "Grano Siberiano Valtellinese" could also be used to make herbal teas or cosmetics (*F. tataricum* is included in the European Cosmetic Ingredient database) as it has been the case for decades in Eastern countries.

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P23 - PHYTOCHEMICAL AND ECOLOGICAL ANALYSIS OF TWO VARIETIES OF HEMP (*CANNABIS SATIVA* L.) GROWN IN A MOUNTAIN ENVIRONMENT (ITALIAN ALPS)

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Hemp (*Cannabis sativa* L., Cannabaceae) is a multifunctional crop that is capable of prompt environmental adaptation. Critical conditions in mountain environment could deeply influence the phytochemical composition of inflorescences (cannabinoids and terpenes) and seeds (fatty acids and protein). In this study, a monoecious cultivar (Futura 75) and a dioecious one (Finola) were tested in a mountain area in Valsaviore (Rhaetian Alps, Italy; elevation: 1.100 m a.s.l.) during the growing season 2018. Ecological (CSR functional strategy of Grime) and phytochemical behaviour (HPLC-high-resolution mass spectrometry and GC-MS approach) of both varieties was considered. Both the genotypes are mainly competitors although Finola is more stress tolerator (C:S:R = 57:26:17%) than Futura (C:S:R = 69:15:16%). The Finola inflorescences were characterised by higher quantities of β -ocimene and α -terpiolene, while in Futura 75 α - and β -pinene accompanied by extremely high β -myrcene were predominated. Both chemovars were particularly rich in sesquiterpenes: 45 different compounds were identified among which trans-caryophyllene and α -humulene were the most abundant. Total tetrahydrocannabinol level was lower than 0.1% and since both varieties analysed belongs to the fibre-type hemp, the most abundant cannabinoid was cannabidiolic acid without significant differences between two genotypes: 2.3% found in Finola vs 2.7% for Futura 75. The level of corresponding neutral form, cannabidiol, varied drastically and it was found 5-times higher in Finola than in Futura 75 (0.27% vs 0.056%). Finola showed the unique cannabinoid profile with unexpectedly high cannabidivarin, 2-fold higher than corresponding acidic analogue, whereas the particularity of Futura 75 was the occurrence of cannabigerolic acid in the quantities that was double than those exposed for Finola. The seeds showed to be rich in polyunsaturated fatty acids and Finola showed a higher ratio ω 6/ ω 3. No difference was found in the protein content and the SDS-PAGE profile was similar. The most abundant protein was the storage protein edestin, directly identified by mass spectrometry, some proteins associated with heat shock were also found. In conclusion, comprehensive quality study of two *C. sativa* fibre-type varieties cultivated in Italian Alps displayed specific, legal and safe cannabinoids profile, followed by particular terpene composition and polyunsaturated fatty acids content. This indicate that hemp inflorescences and seeds variety and provenience should be consider for a specific end-use nutraceutical application.

**P24 - METABOLOMICS, ANTIBACTERIAL ACTIVITY AND
CYTOTOXICITY OF *Arbutus unedo* LEAVES COLLECTED IN TEN
DEFERENT AREAS OF SARDINIA**

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Arbutus unedo L. (Ericaceae family) is an evergreen shrub or small tree native to the Mediterranean region¹. The leaves of this plant have been used in the folk medicine of several Mediterranean countries to treat a large number of diseases, such as kidney afflictions², hemorrhoids and gastrointestinal disorders³. This work is based on *A. unedo* leaves, which emerged as a promising antimicrobial agent, out of 36 samples from Sardinian plants. In particular, plants extracts were tested against *Klebsiella pneumoniae*, *Escherichia coli*, *Staphylococcus aureus* and *Staphylococcus epidermidis*. Moreover, cytotoxicity of extracts was assayed on Vero cells, in order to establish their selectivity index. In this screening, *A. unedo* extract resulted active against *K. pneumoniae* (IC₅₀ of 93.8 µg/mL), and both *Staphylococcus* species (IC₅₀ of 31.9 µg/mL and 10.1 µg/mL against *S. aureus* and *S. epidermidis*, respectively), the CC₅₀ was of 41 µg/mL with a selected index (SI), calculated as the CC₅₀/IC₅₀ ratio for the bacterial strain more susceptible to inhibition, namely *S. epidermidis*, of 4.1. Considering that plants phytochemical profile vary according to seasons and environmental factors, metabolomics-chemometrics approach was applied to compare *A. unedo* leaves metabolome from samples harvested in 10 different areas of Sardinia and at three different time points, during two consecutive years (2017 and 2018).

The ¹H-NMR metabolomic profiles of the hydroalcoholic extracts were treated by PCA, which highlighted remarkable differences among the samples. These differences concern both primary metabolites such as quinic acid and carbohydrates, and secondary metabolites such as arbutin (one of the main active principles of *A. unedo*) and flavonoids (mainly kaempferol and myricitrin derivatives). Hence, the 15 extracts presenting the most diverse metabolic profiles were selected to be tested for antibacterial activities and cytotoxicity to assess whether the metabolomic variations were determining also variations in the bioactivity panel. Further studies are ongoing in order to individuate the active principles, eventually exploiting the metabolomic data to facilitate the overall procedure.

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P25 - NUTRACEUTICAL OLIVE OILS ENRICHED BY CITRUS AND OLEA LEAVES

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The nutritional and health-promoting effects olive oils are more and more recognized. Indeed, it is well known that olive oil is rich in functional bioactive molecules, including tocopherols, carotenoids, and phenolic compounds¹. Phenolic compounds and tocopherols play a protective role against oxidative stress and are able to extend the olive oil shelf life due to their antioxidant properties. The nutraceutical properties of olive oil can be improved by bioactive compounds recovered from different natural sources such as waste or by-products². The leaves are a by-product of olive and citrus cultivations, easily obtained either from pruning or industry activity. Thanks to their richness in bioactive compounds, they can be used during olive pressing as source of low molecular weight polyphenols with potential health benefits, such as tyrosol and hydroxytyrosol. This study aimed to compare the chemical and sensory quality of nutraceutical olive oils enriched with Citrus and Olea leaves. The fresh leaves were previously treated with solid CO₂ as cryogen, to enhance the extraction yield of bioactive compounds³. Composition parameters such as free acidity, peroxide value, chlorophyll and carotenoid concentrations as well as major antioxidants and antioxidant activity were taken into consideration. All the extracted oils showed a chemical profile corresponding to extra virgin olive oil category, while the addition of leaves allowed to improve their nutritional value: in particular, the presence of functional compounds, such as tocopherols and phenols classifies these oils as nutraceuticals with the potential to promote a healthy diet.

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P26 - PHYTOCHEMICAL AND PHARMACOLOGICAL CHARACTERIZATION ON HEMP COMMERCIAL CULTIVARS: FOCUS ON AQUEOUS INFLORESCENCE EXTRACT ACTIVITY

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One of the most promising economic perspectives of hemp (*Cannabis sativa* L., Cannabaceae) production chain is female inflorescence valorization¹. By contrast, scientific literature lacks on chemical composition or biological activity data from aqueous fraction obtained from industrial hemp flowers, which have long been considered as waste products. In this context, the main focus of the following study is the evaluation of protective effects related to aqueous flower extracts from four commercial hemp cultivars (Futura 75, Kc virtus, Carmagnola Cs and Villanova). We evaluated the extract phytochemical profile. Then, we studied the water extracts both *in vitro* and *ex vivo* in order to assay protective effects in an experimental model of ulcerative colitis, constituted by isolated LPS-stimulated colon². All cultivar extracts displayed similar total phenol and flavonoid content. On the other hand, Futura 75 cultivar extract displayed a better antioxidant and anti-inflammatory profile. Considering this, Futura 75 extract has been subsequently assayed to evaluate its effect on pathogen bacterial and fungal species involved in ulcerative colitis, finding a significant inhibition on the growth of *C. albicans* and bacterial strains, such as *Pseudomonas aeruginosa*, *Escherichia coli*, *Staphylococcus aureus*.

Taken together, our results support the potential efficacy of Futura 75 water extracts in managing the clinical symptoms related to ulcerative colitis.

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**P27 - PHYTOCHEMICAL AND PHARMACOLOGICAL PROFILE OF
ORIGANUM SIPYLEUM EXTRACTS: EXPLORING FOR NOVEL SOURCES
 FOR POTENTIAL PHARMACEUTICAL, FOOD, AND COSMETIC
 APPLICATIONS**

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Origanum sipyleum L., an endemic plant of Western Anatolia has been used as a medicinal tea, food additive, and for the production of essential oil¹. In this study, the biological potential of three extracts (ethyl acetate, methanol, and aqueous) of *O. sipyleum* was assessed based on antioxidant activity against key enzymes of clinical relevance. The chemical profile of the plant was assessed using spectrophotometric and LC-MS techniques. Additionally, we explored potential antioxidant and anti-inflammatory effects induced by the extracts in an experimental model of ulcerative colitis induced by LPS challenging². LC-MS analysis revealed that the extracts contained different classes of phenolics, such as rosmarinic acid, phlorizin and gallic acid. We found that the aqueous extract was the most effective antioxidant, displaying the highest DPPH and ABTS scavenging, FRAP, CUPRAC, molybdenum(VI) reducing, and metal chelating effect. The aqueous extract showed the strongest acetylcholinesterase (AChE) inhibition; the methanol extract showed the highest α -glucosidase inhibition, while the ethyl acetate extract was the most effective on butyrylcholinesterase (BChE), tyrosinase, and α -amylase. The total flavonoid content was highest in the aqueous and ethyl acetate extract, respectively. Finally, we found that all extracts were effective in reducing LPS-induced activity of pro-oxidant and pro-inflammatory biomarkers including nitrites, LDH, PGE2 and 5-HT, in rat colon, with the best activity showed by ethyl acetate extract. Our results indicated that the three solvent extracts varied in their chemical and biological profiles, but overall, *O. sipyleum* showed promising therapeutic properties, nonetheless, need to be further validated in *in vivo* models.

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P28 - ANTIOXIDANT ACTIVITY OF SELECTED FRACTIONS FROM METHANOL EXTRACT FROM AERIAL PARTS OF *CARLINA VULGARIS*

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Medicinal plants are a valuable source of chemical compounds, including substances with documented biological properties. In connection with this, new compounds of plant origin are constantly being sought for application in medicine. Valuable indications in these searches are historical ones and ethnopharmacology regarding the medical use of plants. There are many species commonly used in folk medicine, whose chemical composition and biological activity is not fully understood¹. Such plants include various species of the *Carlina* genus. Extracts of these plants are used in ethnomedicine in many countries, now they are used as anti-cancer drugs². The chemical composition of plants of the *Carlina* genus is relatively little known and is limited mainly to *C. vulgaris* species. In the aboveground parts, the presence of: chlorogenic acids, pentacyclic triterpenes, -(among others: ursolic acid, oleanolic acid, lupeol, amyryne) and flavonoids (among others: witeksin, orientin, isoorientin, isoshaftoside)³. The roots contain large amounts of inulin (approx. 20%) and essential oil with the main compound - carlin oxide. The aim of this work is the isolation and identification of active compounds from *Carlina vulgaris* L, (Asteraceae) extracts and their use as potential antioxidative activity. Initial dephractionation was performed by liquid-liquid extraction (hexane, ethyl acetate and butanol) and testing of antioxidant activity by DPPH and FRAP methods showed that the active fraction was the fraction isolated with ethyl acetate.

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P29 - TRADITIONAL ALIMURGIC WILD EDIBLE PLANTS AS A SOURCE OF BIOGENIC AMINES AND POLYPHENOLS

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In the past, when poverty, drought and wars made it difficult to meet subsistence needs, edible wild plants represented an alternative food source or sometimes the only one. Recent ethnobotanical studies demonstrated that many wild edible plants have nutritional or therapeutic value, due to the presence of biologically active compounds, so that they can be considered as food-medicine.

In this study 12 wild food plant species were selected from two previous published studies^{1,2}: 6 belonging to Bologna area (Emilia-Romagna region, Italy) and 6 to Middle Agri Valley (Potenza province, Basilicata region, Italy). The aim of the research was to determine their possible health effects by comparing the biochemical profile of raw plants, cooked plants and cooking water.

Wild raw food plant samples were extracted with methanol. Also aliquots of each plant was boiled in water and then centrifuged: liquid fractions represent cooking water samples, while solid fractions were extracted with methanol, the extracts representing cooked plants. Obtained methanolic and aqueous extracts were analysed using spectrophotometric techniques to assess total protein, total polyphenol and flavonoid contents and antioxidant activity. Results showed most of the compounds being released in the cooking water, which also had the highest antioxidant activity. HPLC-DAD analyses were performed to identify specific phenolics and biogenic amines. The most abundant phenolic compounds (luteolin, luteolin-7-glucoside and rutin) showed concentrations between 100 to 1000-times higher than the average of other identified compounds. Free and conjugated spermidine and spermine were generally the most abundant biogenic amines and higher levels of total amines were determined in cooking water plus cooked plants with respect to raw samples. Most of the phenolic compounds with ascertained health benefits were released in the cooking water, that could therefore represent an efficient food-derived medicinal tool for improving human health, as stated by past local popular traditions.

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P30 - PHYTOCHEMICAL INVESTIGATION OF TERMINALIA MACROPTERA LEAF EXTRACTS HAVING PSYCHOPHARMACOLOGICAL ACTIVITY IN MICE

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The genus *Terminalia* (Combretaceae) includes several medicinal species that are widely exploited in traditional folk medicine in many African and Asian countries¹. Local healers from Northern Nigeria rely on the use of different preparations from *Terminalia macroptera* Guill. organs to treat the symptoms of various infectious diseases (e.g. hepatitis, malaria and enterocolitis) and CNS-related disorders (e.g. epilepsy, anxiety and depression) together with other minor ailments^{2,3}.

In this work we elucidated the phytochemical composition of methanolic and ethylacetate fractions of *T. macroptera* leaf extracts, which exhibited *in-vivo* protective and beneficial behavioural effects in mice models for anxiety and depression. The untargeted metabolomics analysis, performed by RP-UPLC coupled to high resolution ESI-qTOF, revealed a notable composition in polyphenols belonging mostly to the classes of gallic acid esters, ellagic acid derivatives, chebulic and non-chebulic ellagitannins and, in minor amounts, flavonoids. Moreover, in order to investigate the mechanism by which *T. macroptera* metabolites could be responsible for the observed biological activities, we performed preliminary *in-vitro* screening for the evaluation of both antioxidant capacity and the ability to inhibit human monoamine oxidases (MAO) enzymes, involved in the homeostasis of neurotransmitters. The high phenolics abundance resulted in great antioxidant activity of *T. macroptera* leaf extracts tested through ABTS and FRAP *in-vitro* assays. Furthermore, the aqueous extract showed good MAO-A inhibition properties, suggesting a potential relation between specific metabolites of this plant and its ascribed antidepressant and anxiolytic effects.

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P31 - RAPID AND RELIABLE PROCEDURE FOR QUALITY ASSESSMENT OF TEA TREE OIL COMMERCIAL SAMPLES

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Tea tree oil (TTO) is one of the most popular essential oils and it is used both for medical purposes and health care because of its antibacterial, antiviral and antifungal activities¹. TTO derives from the Australian native plant *Melaleuca alternifolia* Cheel (Myrtaceae). Our recent and other studies reported great variability among commercially available TTO products mainly in the contents of terpinen-4-ol, one of the dominant components in TTO formulations²⁻⁴. Indeed, TTO is a complex mixture of hundreds of elements present at high or trace amounts and several factors (i.e. chemotype, environmental conditions, preparation procedures) impact on composition and biological properties of final formulations. Therefore, quality assurance is an essential requisite to guarantee reproducibility among stocks as well as safe and effective use. Compliance with ISO standards and gas-chromatography mass-spectrometry techniques are universally accepted in check of TTO formulations but they are high-priced procedures mainly focused in detection of terpinen-4-ol while adulterations are overlooked⁵. In this study we set a TLC protocol for the easy and cheap quantification of terpinen-4-ol in TTO batches purchased from the marketplace and, if coupled with assay of fatty oils, also for the detection of adulterations. In our idea, this protocol should be used as a preliminary approach for the quality evaluation of TTO batches with feasible and practical applications in small laboratories and by natural product operators.

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P32 - *SANTOLINA INSULARIS*: NEW INSIGHTS ON THE ANTIFUNGAL ACTIVITY OF ESSENTIAL OIL FROM SARDINIA, ITALY

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Santolina insularis (Genn. ex Fiori) Arrigoni, belonging to Asteraceae family, is an endemic aromatic plant of Sardinia. *S. insularis* is used in Sardinian folk medicine for its cicatrizing, as well as anthelmintic, properties. It is reported, that it grows predominantly on Gennargentu (Central Sardinia) and on Marganai-Linas massifs (SW Sardinia)¹⁻³.

The purpose of this study is evaluating the chemical composition and the antifungal activity of *S. insularis* essential oil against several yeasts, dermatophytes and *Aspergillus* strains. The influence, at subinhibitory concentrations, of the essential oil on the dimorphic transition in *Candida albicans* was also studied. The oil, analysed by GC-FID and GC-MS, was mainly composed by β -phellandrene (22.6 %), myrcene (11.4 %), artemisia ketone (7.6 %), γ -curcumene (7.1 %), *ar*-curcumene (5.0 %) and sabinene (4.6 %).

According to the determined MIC and MLC values, *Cryptococcus neoformans* and several dermatophytes (*Trichophyton rubrum*, *T. mentagrophytes*, *T. mentagrophytes* var. *interdigitale*, *Microsporum gypseum* and *Epidermophyton floccosum*) were the most sensitive fungi (MIC values of 0.16 μ L/mL). The essential oil, also, demonstrated a strong effect on the germ tube formation, which constitutes an important virulence factor of *C. albicans*, clearly illustrated by a significant inhibition at values below the MIC (16 times lower than MIC value). Our results show the *S. insularis* essential oil may be useful in the clinical treatment of fungal diseases, particularly dermatophytosis and candidosis.

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P33 - CHEMICAL COMPOSITION AND BIOLOGICAL ACTIVITY OF ESSENTIAL OILS OF *TEUCRIUM CAPITATUM* SUBSP. *CAPITATUM* (LAMIACEAE) FROM SARDINIA ISLAND (ITALY)

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Two populations of *Teucrium capitatum* subsp. *capitatum*¹ were picked up in the coastline in Porticciolo - Alghero, SS, and in the mountainous area of Gennargentu - Arzana, NU. Both sites were characterized by the presence of a mosaic of different plant communities. These locations are important for their abiotic features such as the chemical composition of the geological substrate, geomorphology, bioclimatic area, altitude and distance from sea, which, all together, affect the phytochemical variability. This study had a dual purpose: (1) comparing the volatile compounds extracted by hydrodistillation from the aerial parts of the two population of *Teucrium capitatum* subsp. *capitatum* and (2) evaluating the antifungal activity (minimal inhibitory/lethal concentration, MIC/MLC) of the essential oils against yeasts and dermatophyte strains and, concomitantly, to elucidate the mechanism of action underlying their potential antifungal effect on *Candida albicans*. The extracts were analyzed by GC-FID and GC-MS methods. It was observed a strong chemical variability related to the origin of the samples. For the species under investigation, two chemotypes were identified. The minimal inhibitory and fungicidal concentrations of the essential oils were assessed on reference and clinical strains. The oil of *Teucrium capitatum* from coastline area was very active, particularly against *Cryptococcus neoformans*, and it was very effective in inhibiting *C. albicans* germ tube formation, at doses well below their MIC.

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P34 - ESSENTIAL OIL EXTRACTION AND BEVERAGES AROMATIZATION WITH A BLEND OF TWO FIBRE HEMP CULTIVARS FLOWERS

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Cannabis sativa L. has a well-established traditional use as a multi-purpose crop: its stems have been used since ancient times for fibre production, and its seeds are a high-value dietary product for humans and animals¹. The legal constraint of complying with the Δ^9 -tetrahydrocannabinol (THC) 0.2% threshold established by the EU legislation² has addressed breeding techniques towards an increase in fibre and seed yields³. As a result, the leaves and inflorescences represent most of the threshing residue: the aim of this study was the evaluation of different methods to exploit this biomass. The essential oil extraction is a simple method to obtain a value-added product, whose peculiar and generally well-liked aromatic profile exhibits an odour bouquet that heavily relies on the cultivar. For this study, we extracted and characterized the EO from two cultivars (Uso 31 and Futura 75): mono- and sesquiterpene hydrocarbons were the most abundant chemical classes of compounds, mainly represented by α - and β -pinene, myrcene, terpinolene, β -caryophyllene and α -humulene. A blend of these two cultivar flowers was also used in the aromatization of an artisanal beer (Hempitaly) and of an artisanal liqueur, whose headspace compositions have been analysed to assess the aromatic contribution of the hemp flowers to their bouquet. As the latter is prepared without thermal or mechanical processes that cause an increment in the temperature, its headspace composition exhibited more monoterpene hydrocarbons deriving from the hemp contribution compared to the beer one. The hemp-aromatised beer, indeed, showed a headspace dominated by the non-terpene compounds, mainly esters, showing minor differences compared to the control beer sample. The matrix-effect must also be taken into account. To comply with a greener approach, the hemp agriculture should consider *C. sativa* flowers as a further usable product, both for their use in the aromatization of beverage products, as well as the starting material for the extraction of essential oils.

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P35 - ESSENTIAL OIL COMPOSITION OF TWO *THYMUS VULGARIS* L. CHEMOTYPES UNDER ORGANIC CULTIVATION IN TUSCANY

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The genus *Thymus* L. consists of about 215 species of herbaceous perennial and small shrubs included into the mint family (Lamiaceae), widespread in the Mediterranean region. *Thymus vulgaris* L. species are well known medicinal plants, highly recommended due to a range of therapeutic properties of their essential oils, commonly known as thyme oil: antirheumatic, antiseptic, antispasmodic, antimicrobial, cardiac, carminative, diuretic and expectorant¹. Growth, essential oil yield and quality of aromatic plant species are regulated by environmental conditions, cultivation techniques and vegetative development. The objective of this work was to evaluate the growth and productive parameters as well as the yield and composition of essential oils (EOs) from two *Thymus vulgaris* L. chemotypes (thymol chemotype and linalool chemotype) organically-grown in the hilly land of Tuscany (central Italy), through 2-year field experiment (2017 and 2018).

The plants of each chemotype were collected at the full flowering stage, when volatile oil content was maximum, on four randomized sampling areas (10 m² each). The main agronomic parameters were evaluated on 25 plants for each sampling area. The EOs were obtained from dried aerial parts of the two *Thymus vulgaris* chemotypes by hydrodistillation in a Clevenger apparatus, and then analyzed by gas chromatography coupled with mass spectrometry (GC/MS).

Along the two years of cultivation, total above-ground dry biomass significantly increased from the first to the second year after planting and large variations in the main biological, biometric and productive traits were observed between the two chemotypes. Thymol chemotype showed the highest above-ground yield with mean values ranging from 204 to 878 kg ha⁻¹, in the 1st and 2nd year respectively. The EO yields ranged between 1.2 % in 2017 and 0.56% in 2018 for the ‘thymol’ chemotype and between 2.8% and 1.2% for the ‘linalool’ chemotype in the two reference years. The ‘thymol’ chemotype EO showed thymol as the major constituent (51.26-49.87%) followed by γ -terpinene and *p*-cymene. The ‘linalool’ chemotype EO showed high percentages of oxygenated monoterpenes (about 90%) with linalool (75%), linalyl acetate (8.15%) and β -caryophyllene (3.2%) as main constituents.

This study highlighted that *T. vulgaris* chemotypes can be successfully organically-grown in the hilly lands of Tuscany, with interesting biomass and essential oil yields, even if the plants were in the initial years of crop establishment. The introduction of this species into organic cultivation systems could contribute to obtain high quality raw material, as well as to enhance the diversification of crop rotation, which is of pivotal importance in the management of organic farms.

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P36 - SUPERCRITICAL EXTRACTION OF VOLATILE AND FIXED OILS FROM *PETROSELINUM CRISPUM* L. SEEDS. CHEMICAL COMPOSITION AND BIOLOGICAL ACTIVITY

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The supercritical CO₂ extraction of volatile and fixed oil from dried *Petroselinum crispum* L. (Apiaceae) seeds, is presented in this study. Extraction experiments were carried out in two consecutive stages, both at 40 °C, and at pressure values of (90 or 300) bar.

The extraction step performed at 90 bar produced a volatile fraction mainly formed by the phenylpropanoids: apiole (82.1 %) and myristicin (11.4 %). The volatile oil yield, Y, calculated as mass of extract/mass of starting material, was 2.6 %.

The last extraction step – carried out at 300 bar – produced a fixed oil at a yield of 0.4 %. Analyses of fatty acids were carried out by means of HPLC and GC techniques. The most represented fatty acids of fixed oil from *P. crispum* were: petroselinic acid, 18:1 n-12 (49.9 %); linoleic acid, 18:2 n-6 (18.2 %); oleic acid, 18:1 n-9 (11.8 %); and palmitic acid, 16:0 (7.4 %). The concentration of petroselinic and oleic acids averaged 182.2 mg/g and 92.1 mg/g of extracted oil, respectively.

The quality, in terms of chemical composition, of the oils obtained by SC-CO₂ extraction were compared with that of the oils obtained by hydro-distillation, in a Clevenger apparatus, and by solvent extraction, using *n*-hexane in a Soxhlet apparatus.

The volatile and fixed oils, obtained from *P. crispum*, were evaluated for the antioxidant activity, by means of the ABTS^{•+} assay. The method was performed in triplicate, for each sample at a given concentration, to estimate the EC₅₀ (the concentration of oil required to decrease ABTS^{•+} radical cation concentration by 50 % values). The results indicated that volatile oil possessed low antioxidant activity (EC₅₀ = 0.43 mg/mL) and the fixed oil had no antioxidant activity.

The total phenolic content – evaluated using the Folin–Ciocalteu reagent – in the volatile oil, expressed as gallic acid equivalents, GAE, was quite low: 1.56 mg/g.

A literature search confirmed that phenylpropanoids as myristicin, apiole and γ -asarone are typical constituents of *P. crispum* volatile oil¹ and that petroselinic acid, (as glyceryl tripetroselinate) is the most widespread fatty acid in triacylglycerols found in fixed oils of parsley, *P. crispum* (55.3 % in mol) but also of carrot, *Daucus carota*, (38.8 %) and celery, *Apium graveolens* (38.7 %), all belonging to the Apiaceae family².

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P37 - ANTIBACTERIAL ACTIVITY OF EXTRACTS AND FRACTIONS OF THREE PLANTS OF THE ECUADORIAN TRADITIONAL MEDICINE

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Traditional Medicine (TM) is an ancient practice strongly connected to religious beliefs and deeply embedded in Indigenous culture, which provides the primary health-care needs for the majority of the population in developing countries. Knowledge on medicinal plants is orally transmitted from generation to generation. In Latin American countries, TM is widely used both as a tradition and as an alternative to Western medicine, which is too expensive for most people. Ecuador is one of the most biologically diverse areas in the world, being classified as the “biodiversity-hotspot” for excellence¹. In recent decades, studies of plant bioactive compounds have grown considerably, especially as a basis for new drugs development. Understanding the mechanism of action of these molecules is the key to develop innovative therapies against many diseases². In this work, three plants belonging to the Ecuadorian flora, i.e. *Clinopodium tomentosum* (Kunth), *Salvia quitensis* (Benth) and *Campyloneurum amphostenon* (Kunze ex Klotzsch) were studied for their antibacterial and antioxidant activity. Crude extracts were prepared using a mixture of acidified acetone, water, *n*-hexane, and fractionation of crude extracts was carried out with solvents at different polarity³. Plants were chosen and collected for their use in the TM; *C. tomentosum* is used for treatment of inflammations⁴, while *S. quitensis* is mainly used for its antitussive activity⁵. Dried leaves (*C. tomentosum* and *S. quitensis*) and dried roots (*C. amphostenon*) were used to prepare extracts and fractions. Levels of bioactive compounds belonging to the class of phenolics, i.e. flavonoids, tannins, phenolic acids, were determined in extracts and fractions by HPLC-DAD and spectrophotometric methods. The antioxidant capacity was evaluated using several *in-vitro* methods (DPPH, ORAC, FRAP-FZ). Extracts with the highest yield were the crude extract and residual water (in the range 4-7%) and the hexanic ones (in the range 5-8%). The antibacterial activities of fractions were evaluated *in vitro* against both reference Gram-positive and -negative bacterial strains and clinical isolates of methicillin-sensitive and methicillin-resistant *Staphylococcus aureus* (MSSA and MRSA); in addition, the compounds identified as main components in each extract/fraction were assayed as well for their antibacterial activity. Given the high yield of the last fraction, the essential oil was prepared to test its antimicrobial activity.

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P38 - CHARACTERIZATION OF DRIED RED STIGMAS OF *CROCUS SATIVUS* L. CULTIVATED IN TUSCANY

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Dried red stigmas of *Crocus sativus* L. are a very expensive spice known as saffron, used as a food flavoring and coloring agent and as a traditional herbal medicine¹. The purpose of this paper is to report the analyses of *C. sativus* stigmas sample cultivated in Tuscany in order to characterize this product from a quality point of view for a food or nutraceutical use. In particular the aim of this work is the formulation of two standardized innovative products as a contribution to the treatment of ocular maculopathy linked to age, as well as the production of innovative formulations for mood modulation²⁻⁴. The identification of crocins, safranal, picrocrocin, and flavonols was carried out by HPLC-DAD analyses of the hydroalcoholic (EtOH:H₂O 70:30, pH 3.2) extracts. The following parameters, moisture, ash, fiber, protein, fat, sugars and minerals (Na, K, Mg, Ca, Fe, C, Zn, Mn) were evaluated to draft a nutritional table for the label of commercial saffron. Moreover, the quantitative analyses of an aqueous extract was carried out by spectrophotometric analyses (ISO/TS 3632-2:2003). This method allowed the determination of picrocrocin (100.16 mg/g), safranal (33.7 mg/g) and total crocin (195.38 mg/g) contents. HS-SPME-GC-MS and HS-SPME-2DGC-MS/TOF (SRA-Agilent) were employed for the aroma compounds analysis. GC×GC-MS is currently adopted as separation technique not only because of its high resolution power and sensitivity but also for its ability to produce more widely distributed and rationalized peak patterns⁵ for chemically correlated group of analytes.

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P39 - HS-SPME-GC-VUV AND HPLC-DAD-MS ANALYSIS OF *IRIS PALLIDA* LAM. CULTIVATED IN CHIANTI AREA

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Irones extracted from Iris rhizomes are aromatic compounds used in the perfume and flavor industry to develop violet fragrance. The characteristic violet-like smelling compounds of the essential oil of rhizomes of *Iris florentina* L. and *Iris pallida* Lam. have been known to be three isomeric irones. It is well established that these ketones do not occur in freshly harvested plants but develop over years by a slow process. The specific hydrodistillation of dried and crushed iris rhizomes leads to an essential oil called iris butter. As this essential oil almost exclusively contains irones and fatty acids with no smell its commercial value is directly determined by its irone concentration¹. Similarly, the value of iris rhizomes is closely related to their irone content. GC-VUV is a highly specific analytical technique for compound identification and previous studies have utilized GC-VUV for a variety of applications, including analysis of pesticides, permanent gases, hydrocarbons in fuels, fatty acids and terpenes². *Iris pallida* rhizomes from Chianti area (Florence) were analysed in a GC SRA-Agilent 7890B connected to a VUV 101 detector (VUV Analytics). The VUV detector showed the capability to discriminate among different isomers and to quantify irones in this high value matrix. Rhizomes were even analysed for their polyphenolic content by HPLC/DAD/MS, characteristic constituents in the rhizome are isoflavones, in particular tectorigenin (10.56 mg/g), which reportedly show anti-inflammatory and anti-oxidative properties^{3,4}, phenolic acids and xanthenes like mangiferin and neomangiferin.

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P40 - BIOACTIVE COMPOUNDS PRODUCTION BY CIRCULAR INTEGRATED MODELS AND THEIR INNOVATIVE USES

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Waste and by-product plant materials usually contain a great biological potential that could be exploited by extracting bioactive compounds with high added value before using biomass for energy purposes, through efficient small or industrial scale bio-refineries, according to the modern circular agro-industrial models¹⁻⁷. The extraction techniques are usually based on green processes, using water or low percentages of ethanol as solvents, or super- or sub- critical fluids according to the chemical properties of the active principles that must be preserved from degradation. Where necessary, moderately high temperatures or ultrasounds can be applied to enhance the yields of extraction. The raw extracts are purified and concentrated by integrated sequences of filtration steps with different molecular cut-offs from microfiltration to reverse osmosis to produce concentrated fractions enriched in selected chemical subclasses of bioactive principles. The enriched fractions can be further concentrated under vacuum or spray-dried, which allows for a better stability and standardization of the final products. The exhausted material is suitable for the production of energy (bio-hydrogen and bio-methane, or combustion inside the boiler which supplies the heating plant). Each product is assessed by chromatographic, spectrophotometric and spectrometric (HPLC/DAD/ESI-MS) analysis, to identify, quantify and monitor the content of individual active compounds; further studies follow to investigate the biological properties of the concentrated fractions and to evaluate the industrial sectors of applications. The contents of active principles found for the enriched fractions are around 11% in gallic acid and hydrolysable tannins for the dried fraction of Sweet Chestnut^{2,5}; up to 25% polyphenols (mainly secoiridoid derivatives) for olive leaves concentrated fractions and 29% polyphenols (28% hydroxytyrosol derivatives) for pitted olive pulp concentrated fractions⁵⁻⁷; 935 mg/L total polyphenols for concentrated grape leaves extracts; 148 mg/L total polyphenols for concentrated extracts obtained from dried grape marcs, while the dried powder obtained from grape marcs showed a content of 13 mg/g total polyphenols. Grape seeds residue after mechanical oil extraction showed a content of 7% total procyanidins suggesting for their further exploitation to obtain concentrated fractions with antioxidant and antimicrobial properties¹. The process yields on dried extract are around 5% with respect to the raw material, but they can vary based on the vegetal species and tissues extracted. The energy yields for olive paste after extraction were 0.369-0.161 tep/T biogas, 0.429 tep/T energy⁵. The markets concerned, in addition to that of energy, are agronomics, feed, food, cosmetics, pharmaceuticals, bio-polymeric materials¹⁻⁷.

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P41 - NEW INSIGHTS INTO THE ANTIOXIDANT AND ANTICANCER ACTIVITY OF ESSENTIAL OIL OBTAINED FROM THE FLAVEDO OF “POMPIA”, AN ANCIENT SARDINIAN FRUIT

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Pompia (*Citrus limon* var. *pompia*, Rutaceae) grows in the North-East of Sardinia (Italy) and is an ancient cultivar of uncertain origins¹. This fruit is not consumed fresh for the high acidity and low sugar content of its juice and pulp, nevertheless, it is largely used in traditional pastries^{1,2}. In particular, the pompia albedo is used as a raw material for the preparation of candied fruits, whereas its flavedo for the preparation of liqueurs by hydroalcoholic infusion^{1,2}. We investigated the chemical composition and biological activity (antioxidant and anticancer properties) of the essential oil obtained by hydro-distillation from the peel (flavedo) of pompia (PEO). Gas chromatographic analysis (GC-FID/MS) allowed us to determine the PEO chemical composition: the major compound was *d*-limonene (803.8 mg/mL). PEO showed radical-scavenging activity in the DPPH assay and antioxidant activity in the β -carotene/linoleic acid bleaching test. PEO significantly reduced cell viability (MTT assay) in B16F10 and HeLa cancer cells (IC₅₀ values of 148 and 408 μ g/mL, respectively at 24 h of incubation), cell lines frequently used for oncological studies³, and its toxic effect was mainly associated with limonene cytotoxicity. PEO, at 50 and 100 μ g/mL, significantly increased intracellular free radical levels (H₂-DCF-DA assay) in B16F10 cancer cells, without affecting the cellular phospholipid composition³. The HPLC-DAD analysis of the cancer cell medium after PEO-treatment, revealed the presence of perillic acid, a limonene metabolite with anticancer activity. Our findings⁴ provide new insights for the nutraceutical and therapeutic potential of PEO.

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P42 - VALORIZATION OF *AGASTACHE* VARIETIES FOR THE PRODUCTION OF FLOWERS FOR FOOD PURPOSES: CULTIVATION TECHNIQUES AND BIOCHEMICAL ANALYSIS

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Interreg ALCOTRA ANTEA is a project for the development of edible flower chain, the study of chemical and organoleptic characteristics, and production with sustainable methods. Several species and varieties belonging to *Agastache* genus (Lamiaceae family) are mainly cultivated for ornamental purposes or as a possible medicinal plant ¹, but are not taken into consideration for edible exploitation. Accessions of *Agastache* spp. were already analyzed for essential oil profile ^{2,3} and recent studies proved the antibacterial and antifungal properties ^{4,5}. In addition to a decorative value, flowers of different varieties of *Agastache* have a characteristic taste (mint, licorice, anise, lemon) and can be used both in traditional and innovative cooking. We have selected four *Agastache* lines with different color of flowers and taste to test their edible utilization: *Agastache aurantiaca* (A. Gray) Lint.et Epl. “Sunset Yellow” (yellow, mint and lemon), *Agastache foeniculum* (Pursh) Kuntze “Blue Boa” (light blue, mint and licorice), *Agastache hybrida* “Arcado” (raspberry, light mint), *Agastache mexicana* (Kunth) Lint. et Epl. “Sangria” (cherry red, fruity mint). The varieties were evaluated for their propagation aptitude either *in vivo* (seed, cutting) and/or *in vitro*. Moreover, we evaluated the content of anthocyanins, polyphenols and flavonoids in their flowers, and the antioxidant activity (by DPPH assay). *A. foeniculum* “Blue Boa” was propagated by seed, *A. hybrida* “Arcado” by cuttings, *A. aurantiaca* “Sunset Yellow” and *A. mexicana* “Sangria” by *in vitro* culture. For this purpose, micro-cuttings (one node with two opposite buds) were surface-sterilized for 20' in NaClO 1.5 % solution and rinsed twice with autoclaved distilled water for 10' and placed on a culture medium with MS salts, MS vitamins, BA 0.3 mg/l and sucrose 3 % and agar 0.8% (pH 5.7). The flowers of *A. mexicana* “Sangria” have the highest content of anthocyanins; the flowers of *A. foeniculum* “Blue Boa” and *A. hybrida* “Arcado” have the highest content of polyphenols and flavonoids; the extracts from *A. foeniculum* “Blue Boa” flowers have the highest antioxidant activity.

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P43 - ANTIMICROBIAL ACTIVITY OF SOME SARDINIAN ENDEMIC SPECIES

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Nowadays the discovery of new drug leads from medicinal plants may be reached by a biodiversity-driven approach, that might be highly advantageous when applied with samples originating from regions with high biodiversity¹. In this context, Sardinia island (Italy) deserves particular interest, since it is one of the terrestrial biodiversity hot spots of the Mediterranean basin, due to the geographical isolation and high geological and geomorphological diversity². Sardinian flora consists of 2441 taxa of vascular plants³, of which 295 are endemic; among the latter, 189 are exclusive of Sardinia, 90 Sardo-Corsican and 16 shared also with Tuscan archipelago^{2,4}. With the aim to increase the knowledge on biological potential of Sardinian endemic species, in this work we evaluated the *in vitro* antimicrobial activity of thirteen extracts towards Gram+ and Gram-bacteria. Furthermore, their cytotoxicity on mammalian epithelial cells has been evaluated. Five out of them inhibited one or more bacteria (<50% bacterial growth compared to the extract-free control). In particular, *Limonium morisianum* Arrigoni and *Thymus herba-barona* Loisel. were active against both *Staphylococcus aureus* and *S. epidermidis*, while *Hypericum hircinum* L. *ssp. hircinum* and *H. scruglii* Bacch., Brullo & Salmeri showed activity only towards *S. aureus*. Regarding the effectiveness on Gram-bacteria, *L. morisianum* and *H. scruglii* were able to inhibit *Klebsiella pneumoniae* and only *Santolina corsica* Jord. & Fourr was active against *Escherichia coli*. However, lower inhibition rates have been observed towards Gram- bacteria, compared to those obtained for Gram+ strains. Total phenolic and flavonoid contents of the extracts were also determined and a positive correlation among total phenolic content and increasing antibacterial activity has been observed. Interestingly, low toxicity on mammalian cells was associated to high flavonoids content, suggesting their possible protective role, since they were known as antioxidants. Taken together these results support the potential of these plants, especially *L. morisianum*, as valuable antimicrobial sources worthy of further investigations.

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P44 - CHEMICAL COMPOSITION OF *PAULOWNIA* LEAVES

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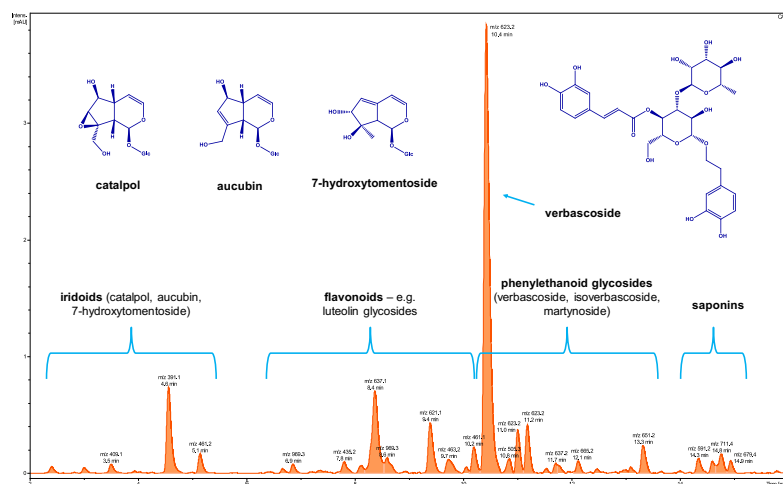
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Paulownia is a genus about 17 species of flowering plants in the family Paulowniaceae. They are native to China, Laos and Vietnam and are cultivated for more than 2000 years. They are deciduous trees 12–15 m tall, with large, heart-shaped leaves 15–40 cm across. *Paulownia* is extremely fast growing, up to 5 m in one year when young.

The tree varieties from this type of tree are extremely adaptive to wide climate and soil factor changes. One of such variety is *Paulownia CLON IN VITRO 112*, which is known as oxytree or oxygen tree and it is a hybrid clone of *Paulownia elongata* and *Paulownia fortunei*. The oxytree plantation can be harvested for saw timber in as little as five years. Once the trees are harvested, they regenerate from their existing root systems.

Paulownia fortunei, commonly is called the Chinese parasol tree. In China is especially popular as a herbal remedy. Extracts from *P. fortunei* are used as traditional medicines to alleviate stomach disorders and diarrhea. As a herb, *P. fortunei* is known to be rich in bioactive compounds including polysaccharides, oleanolic acids, β -sitosterol, syringin and apigenin. This combination of compounds are thought to endow *P. fortunei* with a variety of pharmacological activities, including antibacterial, anti-inflammatory, antitussive, antiasthmatic, immunomodulatory, and other pharmacological effects¹.

Our Q-TOF-LC/MS analysis of the *Paulownia Clon In Vitro 112* leaf extract shows that



The UHPLC-CAD profile of *Paulownia Clon In Vitro 112* leaf extract

the main metabolite, is the verbascoside (acteoside) which belongs to the phenylethanoid glycosides. We found also iridoids like catalpol, 7-hydroxytomentoside and aucubin, as well as flavonoids: glycosides of luteolin, kaempferol and apigenin.

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P45 - BIODIVERSITY WITHIN WILD *HYSSOPUS OFFICINALIS* SUBSP. *ARISTATUS* (GODR.) NYMAN FROM ABRUZZO REGION

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Aerial parts of *Hyssopus officinalis* subsp. *Aristatus* (Godr.) Nyman (synonym *H. officinalis* subsp. *pilifer* (Pant.) Murb.) harvested in different natural habitats (09/2016: Civitaretenga, L'Aquila; 09/2018: Navelli, L'Aquila; 10/2018: Majella, Chieti) of the Abruzzo region (Italy) were characterized based on essential oils and hydro-alcoholic extracts composition. In Italy, this subspecies is found in Lombardia, Trentino-Alto Adige, Veneto, Friuli-Venezia Giulia, Umbria, Lazio, Abruzzo, Molise, Campania, Basilicata and Calabria¹. The chemical characterization of essential oils, performed with GC-MS and NMR analyses, revealed an uncommon composition for the specimen collected in Civitaretenga in 2016, never described in literature: (*l*) limonen-10-yl acetate (67.9%) was the main compound, followed by 1,8-cineole (15.5%) and (*l*) limonene (5.8%)^{2,3,4}. On the other hand, the essential oil belonging to plants harvested in 2018 in the Navelli area (near Civitaretenga) showed a composition comparable to the data published by Hajdari *et al.* (2018) about plants of Western Balkans: *cis*-pinocamphone (43.2%), methyleugenol (15.8%), *trans*-pinocamphone (11.0%), 1,8-cineole (4.4%). The last specimen, collected in Majella, was characterized by essential oil rich in methyleugenol (41.5%), 1,8-cineole (39.7%) and (*l*) limonene (7.6%), as described by Piccaglia *et al.* (1999)⁵. The hydro-alcoholic extracts showed a similar fingerprinting for all specimens, characterized by the main presence of chlorogenic, rosmarinic and caftaric acid (RP-HPLC-DAD) and they also exhibited an interesting antioxidant capacity (DPPH). The plant collected in Civitaretenga in 2016 showed the greatest abundance of every compound. In particular, the quantity of chlorogenic acid was about twice as much as in the other specimens. Since a preliminary screening showed high cytotoxicity of the latter extract against A549 cell line, migration, invasion and wound healing assays were performed but with negative outcomes.

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P46 - ESSENTIAL OIL FROM *PISTACIA LENTISCUS* L. FRUIT CAKE – A NEW APPROACH FOR UTILIZATION OF WASTE FROM EDIBLE OIL PRODUCTION

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The *Pistacia lentiscus* L. is an evergreen member of the Anacardiaceae family consisting of nine species and five subspecies¹. It is largely distributed in the Mediterranean basin Tunisia, Algeria, Morocco, Spain, France, Italy, Greece and Turkey. This plant is widely used in folk medicine to treat various diseases (hypertension, ulcer, eczema and diarrhea) as well as to flavor and conserve diverse aliments². The essential oil extracted from the aerial parts of *P. lentiscus* L. exhibited appreciable antibacterial, antifungal and insecticidal activities³. *P. lentiscus* L. fruit is a source of edible oil, containing a considerable amount of unsaturated fatty acids, carotenoids and tocopherols, natural antioxidants and essential fatty acids. The residue obtained from *P. lentiscus* L fruit after the oil extraction by cold pressing is generally thrown out in the nature. Therefore, the recovery of valuable biologically active substances is an approach to reduce and to valorize the waste generated in the oil industry.

The aim of this study was to prepare essential oil from the *P. lentiscus* L fruit cake and to compare it with those obtained from fruits and leaves of *P. lentiscus* L. The oil cake, fruit and leaves were subjected to a micro distillation-extraction in a Likens-Nickerson apparatus for 2.5 hours using diethyl ether as a solvent. The resulting essential oils were analyzed by GC/MS and more than 60 components in concentration at least 0.1%, representing 98.3, 96.7 and 96.8 % of the total oil were registered. The individual components were identified by their RI and comparison of their mass spectra with those of NIST 14 and homemade MS databases. It has been found that essential oils prepared from fruit and fruit oil cake contained significant amounts of monoterpene hydrocarbons (57-47%) and fatty acids (20.5-30.7%), while the leaf essential oil was found to be rich in oxygenated sesquiterpenoids.

The hydrodistillation of fruit cake is an eco-friendly method producing essential oil rich extract without the risks of solvent contamination and most suitable for any healthy product preparation.

Acknowledgments:

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P47 - NMR AND MS METABOLIC PROFILING AND ANTIPROLIFERATIVE ACTIVITY OF *GYMNOSPERMIUM SCIPETARUM* SSP. *EDDAE*

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Monica Scognamiglio^{a,d}, Leonardo Rosati^c, Simona Piccolella^a, Severina Pacifico^a, Antonio Fiorentino^{a,b}

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The interest in natural product-based drug discovery have increased in a great deal in the last decades. In particular, plants from Berberidaceae family have gained a lot of attention as reservoir of various classes of secondary metabolites (e.g. alkaloids, flavones and saponins) with interesting *in vitro* anticancer activity¹. Among species belonging to the Berberidaceae family, *Gymnospermium scipetarum* Paparisto & Qosja ex E. Mayer & Pulević *ssp. eddae* Rosati, Farris, Fascetti & Selvi, a recently described endemic taxon² of the Southern Apennine (Salerno province, Italy), has been previously investigated through NMR- and MS-based metabolomics³, which unravel its ability to biosynthesize different bioactive secondary metabolites⁴.

In this context, an extract from *G. scipetarum* has been screened for its antiproliferative effects on different human hepatocellular carcinoma cell lines. Interestingly, it has been found that the extract markedly reduces the proliferation of Huh7 cells. Based on these findings, a phytochemical study has been undertaken, and bisdesmoside saponins, flavonol glycosides, isoquinoline alkaloids and caffeoylquinic acids have been isolated. In particular, the chemical characterization of different new oleanane saponins has been carried out through 1D and 2D NMR and HRMS experiments. Further studies are ongoing to understand the inner behavior of the antiproliferative extract.

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Invited speakers

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|------------|--------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|
| PL1 | Frederick Bourgaud Université de Lorraine, France | <i>“«Please, baby, reconsider me »: a new set of technologies to reconcile natural plant compounds and pharmaceutical industry”</i> |
| PL2 | Annalisa Romani University of Florence, Italy | <i>“Bioactive compounds production by Circular Integrated Models and their innovative uses”</i> |
| PL3 | Sonja Sturm University of Innsbruck, Innsbruck, Austria | <i>“Natural product analysis: trends, challenges and pitfalls in an “omics” world”</i> |
| PL4 | Paola Brun University of Padua, Italy | <i>“Phytochemicals and gut microbiota: mutual interactions”</i> |
| PL5 | Saadia Zrira Institut Agronomique et Veterinaire Hassan II, Agdal Rabat, Morocco | <i>“Empowering Moroccan rural women through the valorization of aromatic and medicinal plants”</i> |

Oral communications

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|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| OC1 | Najar Basma , Mecacci Giulia, Pistelli Luisa, Cervelli Claudio, Mancianti Francesca, Ebani Valentina Virginia, Nardoni Simona | <i>“Antifungal and antimicrobial activity of essential oils from some salvia and helichrysum species”</i> |
| OC2 | Marco Biagi , Paolo Governa, Elisabetta Miraldi, Anna Rosa Magnano, Daniela Giachetti | <i>“Phytochemical characterization and gastroprotective activity of <i>Copaifera langsdorffii</i> Desf. Oleoresin and fruit methanolic extract”</i> |
| OC3 | Massimiliano D’Ambola, Soumia Belaabed, Valentina Parisi, Francesca Pedrelli, Ammar Bader, Roberta Cotugno, Angela Bisio , Nunziatina De Tommasi | <i>“Cytotoxic labdane diterpenes from <i>Premna resinosa</i> (Hochst.) Schauer”</i> |
| OC4 | Matteo Caser , Sonia Demasi, Dario Donno, Valentina Scariot | <i>“<i>Crocus sativus</i> L. as a strategic crop for local farms in western Italian Alps”</i> |
| OC5 | Iannuzzi Anna Maria , Braca Alessandra, Sinisgalli Chiara, De Leo Marinella, Milella Luigi, Ostuni Angela, Giani Sergio, Sanogo Rokia | <i>“<i>Adansonia digitata</i> L. (Baobab) from Mali: phytochemical profile, antioxidant and antidiabetic activities of its fruit pulp and leaves”</i> |
| OC6 | De Martino Laura , Elshafie Hazem S., Grul’ová Daniela, Baranová Beáta, Caputo Lucia, Sedlák Vincent, Camele Ippolito, De Feo Vincenzo | <i>“<i>Solidago canadensis</i> L.: a dangerous plant invader as possible pest control”</i> |

- OC7 Demasi Sonia**, Najar Basma, Matteo Caser, Lonati Michele, Gaino Walter, Pistelli Luisa, Scariot Valentina
“Variability of flower traits and essential oil composition in Lavandula angustifolia Mill. of western Italian Alps cultivated on different substrates”
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- OC8 Francesco Fancello**, Giacomo Petretto, Salvatore Marceddu, Tullio Venditti, Giorgio Pintore, Giacomo Zara, Ilaria Mannazzu, Marilena Budroni, Severino Zara
“Antimicrobial activity of gaseous Citrus limon var pompia leaf essential oil against Listeria monocytogenes on ricotta salata cheese”
-
- OC9 Ferrante Claudio**, Zengin Gokhan, Senkardes Ismail, Gevrenova Reneta, Zheleva-Dimitrova Dimitrina, Orlando Giustino, Recinella Lucia, Chiavaroli Annalisa, Leone Sheila, Brunetti Luigi, Picot-Allain Carene Marie Nancy, Rengasamy Kannan RR, Mahomoodally Mohamad Fawzi
“Phytochemical and pharmacological profile of Rubus sanctus and Rubus ibericus extracts”
-
- OC10 Vittoria Graziani**, Odeta Celaj, Cinzia Sanna, Alexandra Garcia Duran, Francesca Esposito, Angela Corona, Enzo Tramontano, Rosangela Marasco, Elisabetta Buommino, Angela Ferro, Brigida D’Abrosca, Antonio Fiorentino
“Metabolomics and biological assays of Sardinian plant species to find secondary metabolites exerting anti-microbial and anti-viral activities”
-
- OC11 Hayouni El Akrem**
“The power of combination of bioactive compounds from aromatic and medicinal plants and beneficial microorganisms: fermented-plant extrates as example”
-
- OC12 Giuliani Claudia, Bottoni Martina**, Santagostini Laura, Papini Alessio, Ascrizzi Roberta, Giovanetti Manuela, Lupi Daniela, Todero Sefora, Basilico Nicoletta, Fratini Filippo, Flamini Guido, Maggi Filippo, Fico Gelsomina
“The Ghirardi botanic garden, beyond the visible”
-
- OC13 Marchese Jose Abramo**, Zanatta Jorge Luiz, Benato Josiane, Dall Agnol Laerte
“Production of highly effective and low cost antimalarial herbal medicine as alternative to monotherapy and artemisinin combination therapy”
-
- OC14 Marengo Arianna**, Maxia Andrea, Sanna Cinzia, Mandrone Manuela, Bertea Cinzia M., Bicchi Carlo, Sgorbini Barbara, Cagliero Cecilia, Rubiolo Patrizia
“Ptilostemon casabonae (L.) Greuter: chemical and biomolecular analyses of a little-known Mediterranean endemism”
-
- OC15 Piccolella Simona**, Crescente Giuseppina, Bianco Alessandro, Candela Lorenzo, Pacifico Severina
“New insights into Inula viscosa bioactive polyphenols”

- OC16** **Marchioni Ilaria**, Pistelli Laura, Ferri Benedetta, Copetta Andrea, Ruffoni Barbara, Pistelli Luisa *“May cold storage condition alters the metabolites and aroma of two edible flowers with lemon-flavour?”*
-
- OC17** **Matteo Politi**, Luigi Menghini, Francesca Mustacchio, Barbara Conti, Stefano Bedini, Pierluigi Cioni, Marinella De Leo, Alessandra Braca *“Lavandin by-products development in a context of multifunctional agriculture: a case study in Tuscany”*
-
- OC18** **Risaliti Laura**, Pini Gabriella, Donato Rosa, Sacco Cristina, Ascrizzi Roberta, Vanti Giulia, Bergonzi Maria Camilla, Bilia Anna Rita *“Artemisia annua essential oils liposomes: optimization and in vitro antifungal activity evaluation against Candida species”*
-
- OC19** **Scariot Valentina**, Demasi Sonia, Caser Matteo *“Domesticating wild species for edible flowers production”*
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- OC20** **Marinella De Leo**, Antonio Vassallo, Claudio Pisano, Alessandra Braca, Nunziatina De Tommasi *“Comparative analyses of different extraction procedures of italian propolis by HPLC-PDA/UV-ESI-MS/MS and evaluation of in vivo anti-inflammatory activity”*
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- OC21** **Vanti Giulia**, Dourdouni Virginia, Lazari Diamanto, Panagiotidis Christos, Piazzini Vieri, Risaliti Laura, Bergonzi Maria Camilla, Bilia Anna Rita *“Melissa officinalis essential oil loading-glycerosomes for the topical appliance against herpes labialis (HSV-1)”*

POSTERS

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| P01 | <u>Giulia Baini</u> , Paolo Governa, Vittoria Borgonetti, Maddalena Corsini, Marco Biagi, Elisabetta Miraldi | <i>Calluna vulgaris</i> (L.) Hull: chemical investigations and antioxidant and antiradicalic effectiveness on human keratinocytes |
| P02 | <u>Bianco Alessandro</u> , Piccolella Simona, Crescente Giuseppina, Pecoraro Maria Tommasina, Candela Lorenzo, Formato Marialuisa, Pacifico Severina | UHPLC-HRMS/MS metabolic profiling of Zucchini cv. ' <i>Lungo Fiorentino</i> ' wastes for their nutra- and cosmeceutical valorization |
| P03 | Vieri Piazzini, Laura Micheli, Mario D'Ambrosio, Lorenzo Cinci, Giulia Vanti, Carla Ghelardini, Lorenzo Di Cesare Mannelli, Cristina Luceri, <u>Anna Rita Bilia</u> , Maria Camilla Bergonzi | Silymarin nanostructured lipid carriers to improve its biopharmaceutical properties and in vivo efficacy in type 2 diabetes |
| P04 | <u>Bottoni Martina</u> , Giuliani Claudia, Milani Fabrizia, Colombo Lorenzo, Colombo Paola Sira, Bruschi Piero, Fico Gelsomina | Interreg B-ICE project: presentation of the ethnobotanic survey in valmalenco |
| P05 | Serralutzu Francesca, Ricelli Alessandra, Stangoni AntonPietro, Teckagne Sidy, Re Giovanni Antonio, Dore Antonio, <u>Bullitta Simonetta</u> | Cropping a natural population of <i>Rosmarinus officinalis</i> L. from n.w. Sardinia. morpho-phenologic variability and biological activity of essential oil |
| P06 | Cennamo Pasqualina, Celaj Odeta, Rega Pietro, Petriccione Milena, Esposito Assunta, <u>Fiorentino Antonio</u> , D'Abrosca Brigida | NMR profiling, qualitative and bioagronomical analysis of pomegranate (<i>Punica granatum</i> L.) fruits |
| P07 | <u>Cerulli Antonietta</u> , Masullo Milena, Montoro Paola, Pizza Cosimo, Piacente Sonia | In depth LC-ESIMS ⁿ -guided phytochemical analysis of <i>Ziziphus jujuba</i> Mill. leaves |
| P08 | <u>Chaouch Mohamed Aymen</u> , Brighenti Virginia, Pellati Federica, Bertelli Davide, Benvenuti Stefania | Chemical composition of bioactive compounds in <i>Prunus domestica</i> L. Waste product |
| P09 | <u>Chatzimavroudis Christodoulos- Stefanos</u> , Papadopoulos Frantzis, Metaxa Eirini, Menexes Georgios, Hadjipavlou-Litina Dimitra, Maloupa Eleni, Lazari Diamanto | Essential oil analysis and study of the antioxidant activity of cultivated oregano |
| P10 | <u>Ilaria Chiochio</u> , Manuela Mandrone, Lorenzo Barbanti, Lorenzo Marincich, Ferruccio Poli | Metabolomic study of <i>Sorghum</i> (<i>s. bicolor</i>) growing on twelve fields in northern Italy |
| P11 | <u>D'Ambrosio Michele</u> | Iridoids and phenylethanoids from <i>Euphrasia rostkoviana</i> |
| P12 | Trendafilova Antoaneta, Todorova Milka, Ivanova Viktoria, Rangelov Miroslav, <u>Danova Kalina</u> | Caffeoylquinic acids and sesquiterpene lactones accumulation in <i>Inula britannica</i> in vitro |
| P13 | <u>Roméo Arago Dougué Kentsop</u> , Elena Lazarova, Francesca Pedrelli, Marco Savona, Martina Fabiano, | Establishment of hairy root cultures of <i>Salvia corrugata</i> Vahl. |

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| | Mauro Giacomini, Barbara Ruffoni, Anna Maria Schito, Nunziatina De Tommasi, Angela Bisio | |
| P14 | Silvia Sillano, Vincenzo Minganti, Francesca Pedrelli, Angela Bisio, Giuliana Drava | Trace elements in edible flowers from Liguria: An exploratory study |
| P15 | D'Urso Gilda, Napolitano Assunta, Masullo Milena, Piacente Sonia | Fruit of <i>Abelmoschus esculentus</i> L. Moench: a rich source of polar lipid and phenolic derivatives |
| P16 | Benedetta Era, Sonia Floris, Silvia Porcedda, Hanen Marzouki, Francesca Pintus, Rosaria Medda, Alessandra Piras, Antonella Fais | Inhibitory effect of <i>Washingtonia filifera</i> extracts on cholinesterases activities |
| P17 | Marino Giuseppe, Celaj Odeta, Piccolella Simona, Celardo Umberto, Stinca Adriano, Pacifico Severina, Fiorentino Antonio, Esposito Assunta | Phytochemical, biochemical and morphological characterization of <i>Phaseolus vulgaris</i> subsp. <i>vulgaris</i> 'Lenzariello' landrace, cultivated on farm in marginal areas of the Campania region |
| P18 | Ferrante Claudio, Orlando Giustino, Zengin Gokhan, Senkardes Ismail, Gevrenova Reneta, Zheleva-Dimitrova Dimitrina, Recinella Lucia, Chiavaroli Annalisa, Leone Sheila, Brunetti Luigi, Picot-Allain Carene Marie Nancy, Mahomoodally Mohamad Fawzi, Menghini Luigi | Phytochemical and pharmacological profiles of <i>Anthemis tinctoria</i> var. <i>pallida</i> and <i>A. cretica</i> subsp. <i>tenuiloba</i> |
| P19 | Era Benedetta, Fais Antonella, Rosa Antonella, Medda Rosaria, Marzouki Hanen, Piras Alessandra, Kumar Amit, Santos-Buelga Celestino, Floris Sonia | Evaluation of biological activities and chemical composition of <i>Washingtonia filifera</i> seeds |
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