AAIC 2024, ASSOCIATION FOR THE ADVANCEMENT OF INDUSTRIAL CROPS

AAIC BOARD OF DIRECTORS

Division Chairs

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TABLE OF CONTENTS

President's Welcome

Welcome to the 35th Annual Conference & Meeting of the Association for the Advancement of Industrial Crops (AAIC 2024). The Association for the Advancement of Industrial Crops (https://aaic.org/) is an international, nonprofit educational and scientific organization established to encourage and promote the activities on industrial crops and products. Industrial crops are utilized for non-food and non-feed applications. These plants provide raw materials and products such as energy, starch, oils, fibers and rubber that are used in different industries. Within the AAIC, research include both crop-oriented and bio-based products and materials topics. The theme of this year's conference is - Constructing a Sustainable Future - The Role of Industrial Crops and Products. In 1987, with the publication of the Brundtland Report, environment and development started to be discussed as one single issue and 'sustainable development' has been defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". The Sustainable Development Goals (SDGs) of the 2030 Agenda of the United Nations (UN), are an action plan in force from 2016 to 2030, comprising 17 goals balancing the economic, social, and environmental dimensions. Agriculture and rural development policies form an important contribution towards achieving the 2030 UN agenda for sustainable development and industrial crops and products can help the nations to meet the UN targets. At the Conference, internationally recognized experts will provide five invited plenary talks, 61 oral presentations - including 5 invited keynote speakers, and 38 poster presentations covering a wide range of topics linked with the AAIC Divisions (Oilseeds; Medicinal and Nutraceutical Plants; Fibers and Cellulosic Crops; Natural Rubber and Resin; General Crops and Products). The half-day Field tour on the 2nd September, and the Technical Visit to Valbopan on the 5th September will allow participants to visit industrial crops processing units in Portugal, and the closing awards banquet will provide an opportunity to honor our deserving colleagues. On behalf of the AAIC board of directors and division chairs, thank you for participating at AAIC 2024.

Ana Luisa Fernando

President of the AAIC

20 August 2024

CONFERENCE PROGRAM

SUNDAY, SEPTEMBER 1

4:00-5:30 PM	AAIC Board of Directors Meeting	Malaca Room
6:00-7:00 PM	Registration Desk Open	Foyer
7:30-9:00 PM	**Welcome Reception**	Tóquio Room

MONDAY, SEPTEMBER 2

PLENARY SESSION*
Moderator: Ana Luisa Fernando
Room: Pequim

8:30-9:00 AM	Registration Desk Open & Poster Set Up		Page #
9:00-9:30	Welcome and Introduction		-
9:30-10:00	J. R. Marques da Silva	Companies environmental, social, and governance scores and the impact on industrial crops development	2
10:00-10:30	Joana Marto	Nature's latest: cutting-edge compounds for cosmetics and dermatology	3
10:30-11:00	**Coffee Break**		
11:00-11:30	Paulina Faria	The use of bio-fibers to optimize buildings performance	4
11:30-12:00	Raúl Fangueiro	Natural Fibers: advanced sustainable solutions	5
12:00-12:30	Elvira Fortunato	From forest to electronics: a sustainable perspective	6
12:30-14:00	**Lunch: Restaurant**		
14:00-22:00	**Conference Field Tour to José Maria da Fonseca cellar with Dinner**		

* Plenary sessions are open to the general public, after free-enrollment to ala@fct.unl.pt

Note: Page numbers correspond to the page the abstract is in the book of abstracts

TUESDAY SEPTEMBER 3

CONCURRENT SESSION
SESSION I: OILSEEDS DIVISION
Room: Pequim A

Moderator: *Hussein Abdel-Haleem & Grace Chen*			
9:00-9:30 AM	***Keynote speaker:*** *Roy A. Scott*	Production of industrial crops at a crossroad: how are we positioned for sustainable production to meet current and future demands?	8
9:30-9:45	David Horvath	The pan-genome of *Camelina sativa*: structural variations, gene-set differences, phylogeny, and markers	9
9:45-10:00	Jinita Sthapit Kandel	Quantitative trait loci for seed size and weight in a camelina biparental population	10
10:00-10:15	Russ W. Gesch	Double cropping with early maturing winter camelina	11
10:15-10:30	Efthymia Alexopoulou	Sowing strategies for camelina in the Mediterranean region	12
10:30-11:30	**Coffee Break & Poster Session [Oilseeds] & [Medicinal and Nutraceuticals] Macau Room**		
Moderator: *Hussein Abdel-Haleem & Russ Gesch*			
11:30-11:45	Elena Pagani	Enhancing sustainable camelina cultivation through intercropping: a pathway towards climate neutrality	13
11:45-12:00	Noemi Codina-Pascual	Effect of fertilization source on yield and oil quality of three camelina varieties	14
12:00-12:15	Rossella Mastroberardino	Camelina response to salinity from germination to rosette stage: preliminary implication for Mediterranean regions	15
12:15-12:30	Federica Zanetti	Revealing the physiological and productive responses of camelina to drought stress	16
12:30-12:45	Marisol T. Berti	Do nitrogen rates affect carbon intensity in spring and winter camelina?	17
12:45-13:00	Grace Chen	Mechanisms of hydroxy fatty acid biosynthesis in lesquerella (*Physaria fendleri*)	18
13:00-14:15	**Lunch and Members Business Meeting: Restaurant**		

Moderator: *Hussein Abdel-Haleem & Grace Chen*			
14:15-14:30	Winthrop B. Phippen	Commercialization of pennycress (*Thlaspi arvense* L.) as a sustainable aviation fuel source	19
14:30-14:45	Hussein Abdel-Haleem	Genetic diversity and population structure of the USDA sesame accessions	20
14:45-15:00	Liv S. Severino	Characterization of fractions of castor meal separated by particle size	21
15:00-16:00	**Coffee Break & Poster Session [Fibers and Cellulosics] Macau Room**		
16:00-16:15	Efthymia Alexopoulou	Long-term screening trials for castor bean in Greece	22
16:15-16:30	Roque L. Evangelista	Physical, chemical, and thermal properties of *Orychophragmus violaceus* seeds and oil	23
16:30-16:45	**Oilseeds Division Meeting -** Division Chair: *Hussein Abdel-Haleem*		

CONCURRENT SESSION
SESSION II: MEDICINAL AND NUTRACEUTICAL PLANTS DIVISION
Room: Pequim B

Moderator: *Valtcho D. Zheljazkov & Hanin Mukhlid*			
9:00-9:30 AM	***Keynote speaker:*** *Laura De Martino*	Harnessing nature's remedies for a green tomorrow; the role of medicinal and aromatic plants	25
9:30-9:45	Valtcho D. Zheljazkov	Natural products for control of sprouting in potato	26
9:45-10:00	Hanin Mukhlid	The efficacy of essential oil blends as potato sprout suppressant and natural antimicrobial agents	27
10:00-10:15	Areej Alzarqaa	Essential oils to suppress potato sprouting at room temperature	28
10:15-10:30	Daniela Rosa	Phytotoxic effects of sesquiterpene lactones enriched fractions against weeds and its possible use as a bioherbicide	29
10:30-11:30	**Coffee Break & Poster Session [Oilseeds] & [Medicinal and Nutraceuticals] Macau Room**		
11:30-11:45	Maria L. Flores-López	Alternative technologies for the extraction of β-carotene from *Rhus microphylla* fruit	30

11:45-12:00	Maria L. Flores-López	Phytochemical composition and bioactive properties of extracts from *Eysenhardtia texana* using conventional and deep eutectic solvents	31
12:00-12:15	Tanja Z. Dodoš	Essential oil variability of natural populations of *Satureja subspicata*	32
12:15-12:30	Carolina V. Domingos	PLA-curcumin biopolymers: shining a light onto potential photodecontaminating materials	33
12:30-12:45	Diana Jasso de Rodriguez	Antifungal activity of extracts from plants of the semiarid zones against *Alternaria tenuissima*, *Fusarium oxysporum*, and *F. solani*, isolated from peach trees	34
12:45-13:00	Nirmal Joshee	Scutellaria: bioactive compounds, medicinal properties, and bioeconomy prospects	35
13:00-14:15	**Lunch and Members Business Meeting: Restaurant**		
14:15-14:30	Ana Sanches Silva	Exploring crops for food packaging applications	36
14:30-14:45	Srinivasa Rao Mentreddy	Production potential of three high-value medicinal herbs, turmeric, basil, and mountain mint in north Alabama	37
14:45-15:00	**Medicinal and Nutraceutical Plants Division Meeting -** Division Chair: *Valtcho D. Zheljazkov*		
15:00-16:00	**Coffee Break & Poster Session [Fibers and Cellulosics] Macau Room**		

CONCURRENT SESSION
SESSION III: FIBERS AND CELLULOSIC CROPS DIVISION
Room: Pequim B

Moderator: *Dilpreet Bajwa & Victor Souza*			
16:00-16:30	***Keynote speaker:*** *Diana P. Ferreira*	The potential of multifunctional natural fibers: from macro to nano scale	39
16:30-16:45	Dilpreet S. Bajwa	Application of cellulose nanocrystals to improve thermal energy storage in salt hydrate systems	40
16:45-17:00	Urtė Stulpinaitė	The decomposition of fiber hemp residues in the soil	41
17:00-17:15	Gülşah Balamut Arslan	Utilization of coffee ground waste as furniture material	42

WEDNESDAY, SEPTEMBER 4

CONCURRENT SESSION
SESSION IV: NATURAL RUBBER AND RESIN DIVISION
Room: Pequim A

Moderator: *Grisel Ponciano & Manuel Carmona*			
9:00-9:30 AM	***Keynote speaker:*** *Sam Wang*	Deficit irrigation on guayule (*Parthenium argentatum* A. Gray) growth and rubber production	49
9:30-9:45	Guayente Latorre	Pollination tests on guayule (*Parthenium argentatum* A. Gray) with two species of diptera: *Sphaerophoria rueppellii* and *Lucilia sericata*	50
9:45-10:00	Colleen McMahan	Growth characteristics of historically significant manzanar guayule (*Parthenium argentatum* A. Gray) plants under greenhouse conditions	51
10:00-10:15	Kimberly Ogden	Climate smart guayule (*Parthenium argentatum* A. Gray)	52
10:15-10:30	Michel Dorget	Guayule (*Parthenium argentatum* A. Gray) business development	53
10:30-11:30	**Coffee Break & Poster Session [Natural Rubber and Resin] & [General Crops and Products] Macau Room**		
11:30-11:45	Grace Chen	Shoot regeneration capability and partial self-incompatibility of a *Taraxacum kok-saghyz* germplasm	54
11:45-12:00	Chaorong Tang	Preliminary evaluation on Russian dandelion (*Taraxacum kok-saghyz*) germplasms from XinJiang, China and efficient genetic transformation of a high-rubber germplasm	55
12:00-12:15	Kaiye Liu	Genetic dissection and identification of candidate genes for girth and rubber yield in *Hevea brasiliensis*	56
12:15-12:30	Pedro J. Garcia-Cano	Sesquiterpenes as biomarkers for guayule (*Parthenium argentatum* A. Gray) genotypes classification	57

13:00-14:15	**Lunch: Restaurant**		
14:15-14:30	Emilio J. González	Fractionating guayule (*Parthenium argentatum* A. Gray) essential oil: volatile characterization and antioxidant activity	58
14:30-14:45	Miguel A. de la Cruz-Morcillo	Combination of argentatin A and 5-FU exerts a synergistic effect and induce late apoptosis on the colorectal cancer cell line RKO	59
14:45-15:00	Aniela M. Silva-Nolasco	Argentatins sensitize non-small lung cancer cells (NCL-H1299) resistant to cisplatin treatment	60
15:00-15:15	**Natural Rubber and Resin Division Meeting -** Division Chair: *Grisel Ponciano*		
15:15-16:00	Break		
16:00-16:30	**Coffee Break**		

CONCURRENT SESSION
SESSION V: FIBERS AND CELLULOSIC CROPS DIVISION (CONT.)
Room: Pequim B

Moderator: *Dilpreet Bajwa & Victor Souza*			
9:00-9:15	Merve Aslan Kadiz	Investigation of crop residues for acoustic panel production	43
9:15-9:30	Burton L. Johnson	Industrial hemp cultivar grain yield performance in North Dakota	44
9:30-9:45	Dilpreet S. Bajwa	Moisture characteristics of biodegradable composite hydromulches for sustainable organic horticulture	45
9:45-10:00	Efthymia Alexopoulou	Comparative yield studies between hemp and kenaf in Greece	46
10:00-10:15	Cássia H. Barbosa	From farm to packaging: incorporating *Cynara cardunculus* L. leaf extract in whey protein-based biopolymers	47
10:15-10:30	**Fibers and Cellulosic Crops Division Meeting -** Division Chair: *Dilpreet Bajwa*		
10:30-11:30	**Coffee Break & Poster Session [Natural Rubber and Resin] & [General Crops and Products] Macau Room**		

CONCURRENT SESSION
SESSION VI: GENERAL CROPS AND PRODUCTS DIVISION
Room: Pequim B

Moderator: *Efthymia Alexopoulou & Mariusz Stolarski*			
11:30-12:00	***Keynote speaker**: Nicolai David Jablonowski*	Investigating marginal soils for improved and sustainable crop production in a unique research field infrastructure	62
12:00-12:15	Efthymia Alexopoulou	Cultivation of energy crops on polluted lands for bioenergy production	63
12:15-12:30	Alexandro Ferreira	Evaluation of innovative cropping system in marginal hill area in north Italy	64
12:30-12:45	Efthymia Alexopoulou	Producing lignocellulosic feedstock by cultivated selected lignocellulosic crops on lignite mining areas for advanced biofuels production	65
12:45-13:00	Bruno Barbosa	Opportunities and constraints associated with the production of energy crops in contaminated soils – identification of pathways to a green economy	66
13:00-14:15	**Lunch: Restaurant**		
14:15-14:30	Alicia Sanchez-Gorostiaga	Promoting the sustainable cultivation of *Cistus ladanifer* L. for bioeconomic growth in demographically challenged areas	67
14:30-14:45	Mariusz Jerzy Stolarski	Production and cascading use of perennial industrial crops biomass	68
14:45-15:00	Long Li	Intercropping with pulse crops increases micronutrient acquisition and controls rust disease on maize	69
15:00-15:15	G. E. Ogden	Development of lab-scale guayule bagasse pyrolyzer	70
15:15-15:30	Magdalena Borzęcka	Digital tools in the bioeconomy	71
15:30-15:45	Mariana Abreu	How GIS tools can help to identify marginal soils for the bioenergy sector in mainland Portugal	72

15:45-16:00	**General Crops and Products Division Meeting** Division Chair: *Efthymia Alexopoulou*
16:00-16:30	**Coffee Break**

16:30-18:00	**AAIC Board Meeting – Malaca Room**
19:00-22:00	**AAIC Awards Banquet and Members Business Meeting - Tóquio Room**

THURSDAY, SEPTEMBER 5

9:00-20:00	**Conference Technical Visit to Valbopan, Famalicão da Nazaré with Lunch**

POSTER SESSION

Room: Macau

CONFERENCE VENUE

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1990-092 Lisboa
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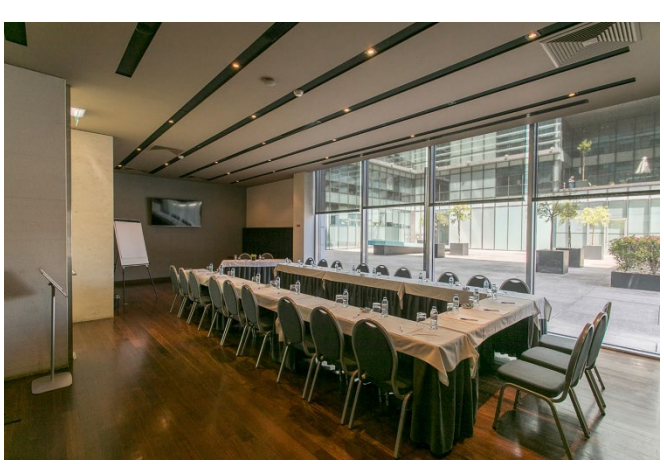
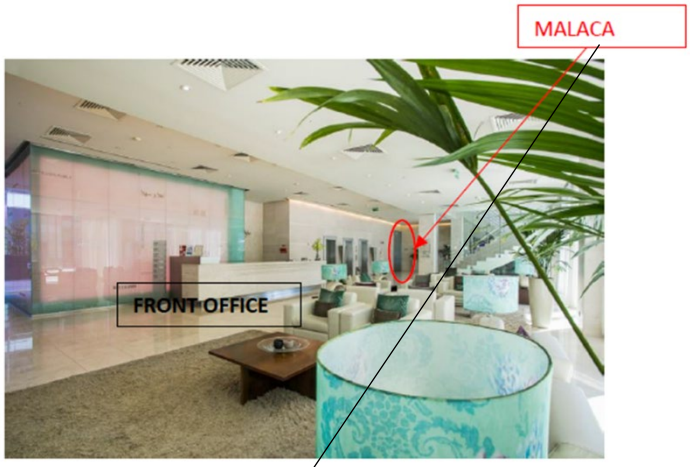
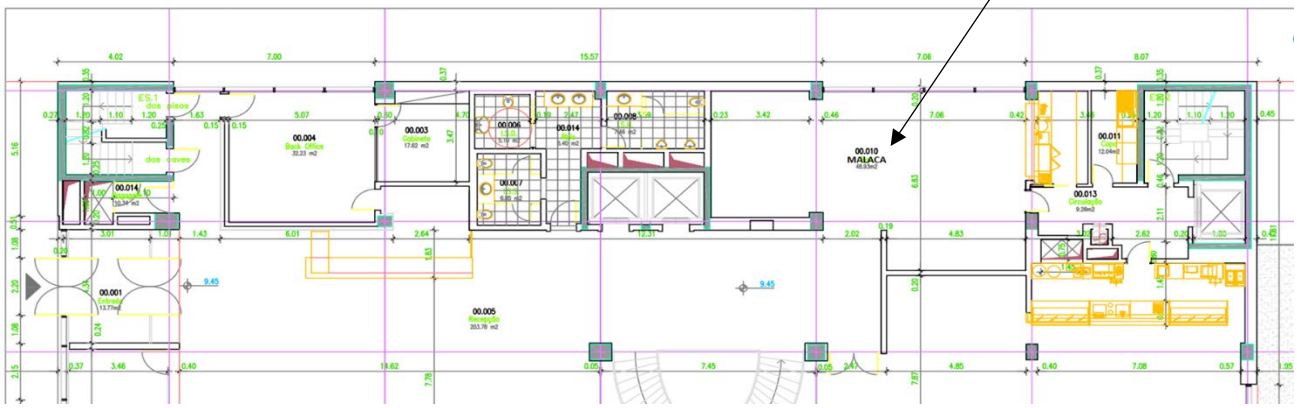
1ST FLOOR . MALACA ROOM







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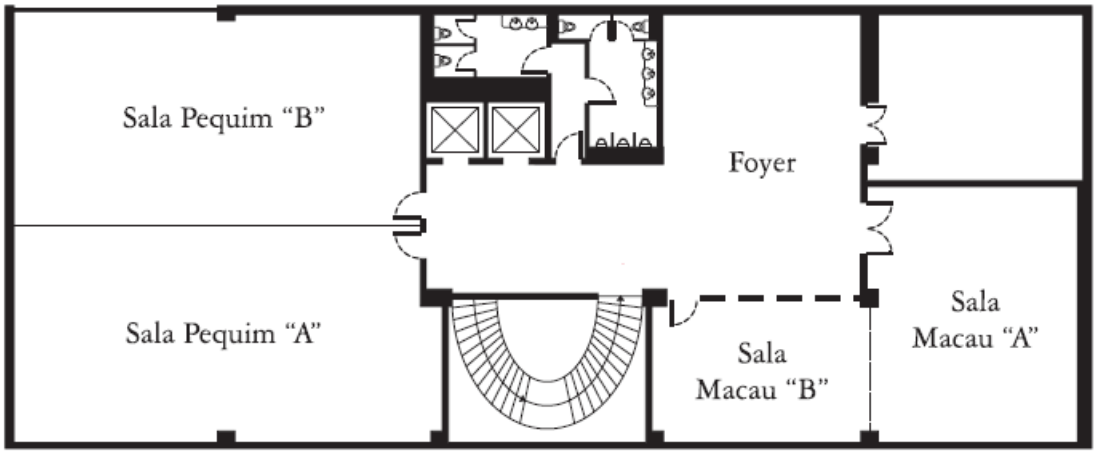

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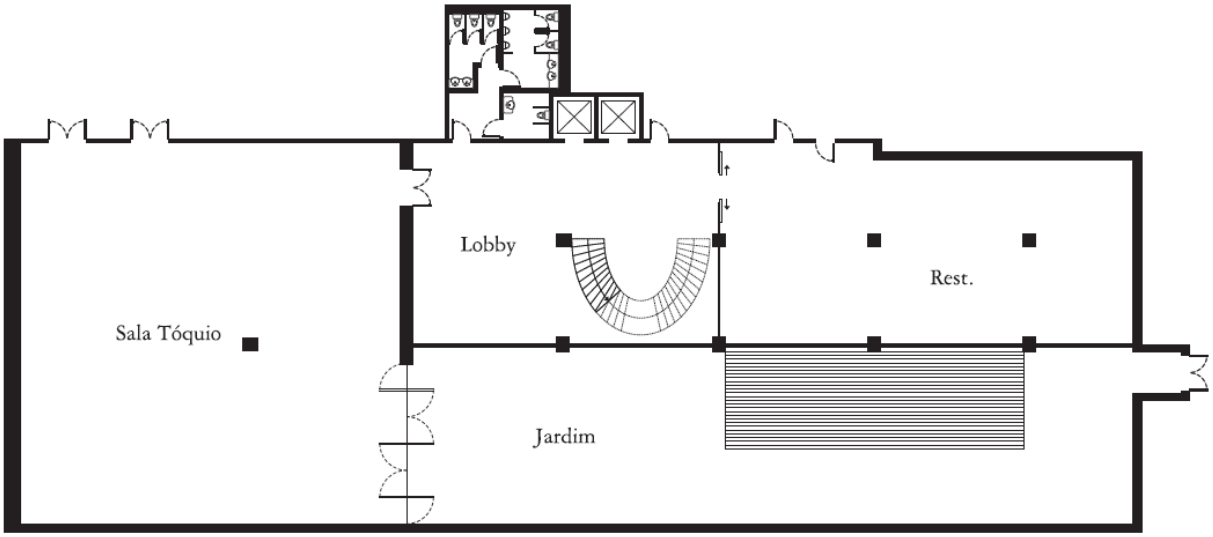

ABSTRACTS

PLENARY SESSION PRESENTATIONS

MODERATOR: ANA LUISA FERNANDO

DEPARTAMENTO DE QUÍMICA, NOVA SCHOOL OF SCIENCE AND TECHNOLOGY, UNIVERSIDADE NOVA DE LISBOA, CAPARICA, PORTUGAL

NOTE: ALL ABSTRACTS IN THIS BOOK HAVE BEEN CORRECTED BY THE DIVISION CHAIRS AND BOOK OF ABSTRACTS EDITOR FOR GRAMMAR, SPELLING, AND FORMAT.

COMPANIES ENVIRONMENTAL, SOCIAL, AND GOVERNANCE SCORES AND THE IMPACT ON INDUSTRIAL CROPS DEVELOPMENT

J. R. Marques da Silva [1,2]

[1] UNIVERSITY of ÉVORA / MED / CHANGE, Évora, Portugal
[2] Agroinsider Lda, Évora, Portugal

Environmental, social, and governance (ESG) scores are all about making a difference: to the planet, to your people and to your organization. So, what is it? and how is it important to any economic activity such as agriculture and industrial crops development? ESG scores encapsulate several standards that measure how an organization's activities contribute to sustainable, viable development, and how that organization minimizes its negative impacts on the planet, its people, and itself. ESGs are also known as the non-financial report that the largest European companies will be required to include in their annual reports starting in 2024. This practice has already been adopted by various companies globally for several years. Gradually, by 2026, it is estimated that 54, 000 companies in Europe will be mandated to present this type of non-financial report, with well-defined obligations and specific characteristics. One of the requirements of ESG reporting is to monitor the value chain to understand the upstream and downstream ESG footprints of the company's activities. Companies that are not yet required to publish this type of annual report are already anticipating this new standard within their operations, as they recognize that ESG indicators (**Environment**: climate change, ecological footprint, and resource use; **Social**: health and safety, customer responsibility, community impact and labor standards; **Governance**: risk management, tax transparency, and anti-corruption) will influence the cost of bank credit, making it cheaper or more expensive depending on the company's scores in these three areas. Food industries need to consult their suppliers, requiring a set of data that agricultural companies will need to start providing if they wish to remain operational in the market. Food industries will have to deal with different types of footprints from suppliers and from them choose the best footprint suppliers in order to have a sustainable and competitive business. What type of data will be relevant and what is the relative value of this data for their business?

Contact: J. R. Marques da Silva, UNIVERSITY of ÉVORA / MED / CHANGE, Évora, Portugal and Agroinsider Lda, Évora, Portugal. E-mail: jmsilva@uevora.pt; rafael@agroinsider.com

NATURE'S LATEST: CUTTING-EDGE COMPOUNDS FOR COSMETICS AND DERMATOLOGY

Joana Marto[1]

[1] iMed.ULisboa, Faculty of Pharmacy, Universidade de Lisboa

The growing demand for sustainable and eco-friendly products has propelled the cosmetic industry to explore innovative sources of bioactive compounds. Food by-products, due to their rich composition of valuable nutrients and bioactive compounds, present a remarkable opportunity. This talk aims to synthesize current research on the potential of various food by-products, including fruit peels, seeds, and pulp residues, as key ingredients in cosmetic formulations. We examine these compounds' extraction methods and efficacy, focusing on their antioxidant, anti-inflammatory, and antimicrobial properties. The literature review covers the latest advancements in the field, including these natural extracts' biochemical properties and potential applications. In addition to the literature review, we present several practical case studies developed by our research group. These case studies illustrate the successful integration of food by-products into skincare products, demonstrating their effectiveness in enhancing skin health, anti-aging, and overall dermatological wellness. Through a combination of *in vitro* and *in vivo* studies, we assess the safety and performance of these food-derived ingredients, providing empirical evidence of their benefits.

Contact: J. Marto, Research Institute for Medicines (iMed.ULisboa), Faculty of Pharmacy, Universidade de Lisboa, Avenida Professor Gama Pinto, Lisboa, 1649-038, Portugal; E-mail: jmmarto@ff.ulisboa.pt

THE USE OF BIO-FIBERS TO OPTIMIZE BUILDINGS PERFORMANCE

Paulina Faria

CERIS, NOVA School of Science and Technology, NOVA University Lisbon, Portugal

Bio-fibers and other biomasses were one of the available materials when mankind started to build shelter. Therefore, since prehistoric times, these natural-based materials were used as building materials directly and to produce building products and structures. Later on, these materials continued to be used to build housing and other buildings worldwide. Many examples of vernacular building products and technologies can be presented using bio-fibers and other biomasses. However, with time and the discovery of many other building materials and products, such as cement, cementitious products, such as concrete, fired ceramic, etc., for more than two millennia many of the vernacular bio-based materials were frequently replaced by those, more recent, building materials, products and technologies. That situation started to change a bit in the last decades due to the increase of environmental impact of the construction industry, the conscience of stakeholders that the status needs to change and the increased importance attributed to environmental performance of buildings, namely their life cycle analysis. In fact, the bio-fibers and other biomasses can improve some characteristics of building products, such as increasing their hygroscopicity and the capacity of passively equilibrating indoor moisture, increasing their thermal conductivity and contribution for thermal insulation, lowering the density, among others. Also, bio-based materials can be used together with some conventional cementitious and thermally treated products, and with lower carbon matrices. Of course, the effect on building products depends on the type of bio-based materials used and their content, for the production of different building products, and has to be optimized. But when embodied in building products and technologies, bio-based materials can also act as carbon sinks, decreasing or, when used together with other low embodied energy technologies, even turning negative the embodied CO_2 of buildings. Furthermore, they are commonly agro-industry wastes and can even be used after extracts being obtained by chemical industries or after turned into ashes and chars to produce heat. Therefore, their incorporation in buildings contributes to decrease the volume of waste to manage and to close the loop or circularity. However, in comparison to conventional building products, stakeholders may have some doubts when considering the use of products with bio-materials, namely in terms of biological colonization and safety in case of fire. Therefore, a lot of research is being done nowadays to optimize the drivers and control the barriers. All these aspects are intended to be discussed.

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NATURAL FIBERS: ADVANCED SUSTAINABLE SOLUTIONS

Raúl Fangueiro[1,2]

[1] Fibrenamics-Institute of Innovation in Fiber-Based Materials and Composites, Azurém Campus, Guimarães, Portugal
[2] Center for Textile Science and Technology (2C2T), University of Minho, Azurém Campus, Guimarães, Portugal

Natural fibers can provide advanced sustainable solutions. Indeed, natural fibers can provide feedstock for advanced fibrous and composite materials (nano, smart, and composites) and structures (3D, auxetic, multiscale), mainly for building, defense, architecture and health-care applications. Recent advances in this field will be presented, including innovation projects with companies from different industrial sectors, that transform knowledge into added value products and technologies.

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FROM FOREST TO ELECTRONICS: A SUSTAINABLE PERSPECTIVE

Elvira Fortunato

CENIMAT|i3N, Department of Materials Science, School of Science and Technology
NOVA University Lisbon and CEMOP/UNINOVA, Caparica, Portugal

According to the United Nations University's Global e-waste monitor, a record of 62 MT of electronic waste was generated worldwide in 2022, which represents a record in human history, up 21% in only five years. The report also predicts that global e-waste will reach 82 MT by 2030 [1]. This makes e-waste the world's fastest-growing domestic waste stream, powered mainly by higher consumption rates of electric and electronic equipment, short life cycles, and few options for repair. Sometimes it is mentioned that "e-waste is a toxic waste stream where valuable finite resources are lost". The global consumption of electronics is forecast to double by 2050. In this context, printed electronics and 3D printing are an interesting alternative to conventional manufacturing methods and materials, reducing the weight of electronic components and offering more energy-efficient and sustainable solutions. Therefore, electronics, including flexible printed circuits, are facing a critical challenge: How to balance decreasing supplies with growing volumes of e-waste? In part: by using new sustainable approaches, either in terms of materials and technological processes! Here we propose the use of a new manufacturing technology supporting flexible and organic/inorganic electronics by exploring single laser processes for direct generation of conductive structures on biodegradable substrates. By means of different kinds of laser sources, conductive carbon nanostructures can be generated on carbon-based precursor materials and substrates via a thermo-photo pyrolysis: the so-called Laser Induced Graphene (LIG). One of the main advantages of the LIG process is that the precursor materials and the substrates themselves can be bioderived and biodegradable, thus allowing new opportunities for sustainable electronics, avoiding the need to use scarce and difficult-to-recycle metal materials and be reused, in addition to costly and time-consuming processes. In this presentation we will demonstrate the use of the LIG process to a set of devices ranging from electronic to biomedical applications.

[1] https://ewastemonitor.info/the-global-e-waste-monitor-2024/

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ABSTRACTS

OILSEEDS DIVISION

ORAL PRESENTATIONS

CHAIR

HUSSEIN ABDEL-HALEEM

USDA-ARS ALARC, MARICOPA, AZ, USA

PRODUCTION OF INDUSTRIAL CROPS AT A CROSSROAD: HOW ARE WE POSITIONED FOR SUSTAINABLE PRODUCTION TO MEET CURRENT AND FUTURE DEMANDS?

Roy A. Scott

USDA Office of National Programs, 5601 Sunnyside Ave, GWCC 2WS-2011, Beltsville, MD 20705-5140. USA.

This address will discuss current USA national priorities, outline USDA proposed research responses to national executive orders, and ask important questions about current industrial crops research portfolios, how national or global questions affect public industrial crops research priorities and propose possible solutions. We will discuss the process by which USDA priorities are established and highlight key high-level research topics that affect priority setting and formulation of USDA industrial crops research. We will discuss the importance of communication among various research and policy agencies in arriving at the best priorities and research strategies to potentially achieve sustainable systems for improving areas such as bioenergy crops. Important areas include production and best practices for sustainable production of bioenergy feedstocks, with emphasis on oilseeds. In a rapidly changing oilseed crops industry, the research environment is volatile, and requires effective agility. It is hoped that this discussion will provoke examination of whether, or not, the right innovations are being implemented by the industrial crops research agendas as we seek to remain resilient. We will discuss USDA strategies for implementing research in key areas such as biotechnology for enhancing rapidity of research to benefit research outcomes, such as reducing product development timelines.

Contact Roy A. Scott, National Program Leader, Oilseeds, Cotton, Pulse Crops, Bioscience, Tel: 240-447-1463. Email: Roy.scott@usda.gov

THE PAN-GENOME OF *CAMELINA SATIVA*: STRUCTURAL VARIATIONS, GENE-SET DIFFERENCES, PHYLOGENY, AND MARKERS

David Horvath[1], Bjorn Usadel[2], Isobel Parkin[3], Daniel Kliebenstein[4], James V Anderson[1], Barbara Dobrin[1], Marius Weisweiler[2], Raju Chaudhary[3], and Kevin Bird[4]

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Camelina [*Camelina sativa* (L.) Crantz] is an emerging oilseed crop with multiple industrial uses including serving as a feedstock for renewable biofuel production. Currently, 37 high quality, long-read assemblies of genomes have been completed for various camelina cultivars – including both spring and winter biotypes. A collaboration between three groups has been established to develop and analyze the pan-genome of camelina. Initial assessments have identified structural variations including presence-absence variations of considerable length, inversions and potential translocations. We have also identified variation in gene numbers between cultivars. For example, an alignment of genes from Chromosome 1 between a winter biotype (Joelle) and a spring biotype (CO46) identified over 400 single gene presence-absence differences, one inversion, and 11 insertions of 10 or more genes with one insertion containing over 120 genes. Outcomes from this ongoing project will report on a full assessment of differences in gene complements and enrichment analyses of the genes associated with presence-absence variations. We will also present a phylogenetic analysis of the sequenced cultivars. Implications of the phylogeny and variations in gene compliments between cultivars and associated phenological traits and environmental responses will also be discussed. Additionally, data on SNP variations between the cultivars that should be suitable for mapping traits within this set of genomes will be presented.

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QUANTITATIVE TRAIT LOCI FOR SEED SIZE AND WEIGHT IN A CAMELINA BIPARENTAL POPULATION

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Camelina [*Camelina sativa* (L.) Crantz] is an annual oilseed crop from Brassicaceae family that has potential as a low-input, high value oilseed crop for food, feed, and biofuel industries. Camelina consists of both spring and winter biotypes. Winter biotypes have low temperature tolerance and can be planted in the fall and harvested early in the summer, allowing for double- and relay-cropping options in the northern Great Plains. However, to enhance camelina as a cash crop, improvement of agronomic traits like seed size and seed quality is important. This study focused on evaluating variation in seed size and thousand grain weight (TGW) and identifying associated quantitative trait loci (QTL) in a biparental camelina population developed from crossing a spring (CO46) and a winter (Joelle) biotype. The population of 254 recombinant inbred lines (RILs), represented by 67 spring, 124 intermediate, and 63 winter biotypes, was phenotyped for seed area and weight using a MARViN ProLine II Seed Analyzer. Variation in TGW [0.71 to 1.27 grams (g)] and seed area (1.20 to 1.76 mm^2) was observed among the RILs. One-way ANOVA identified significant differences in TGW and seed area with spring types having the greatest (1.09 g, 1.54 mm^2) and winter types the lowest (0.96 g, 1.43 mm^2) TGW and seed area, respectively. Pearson correlation analysis indicated positive correlation between TGW and seed area (r= 0.88, $P < 0.0001$). Genotyping-by-sequencing of the RILs identified 2,412 single nucleotide polymorphism markers that were used to create a linkage map consisting of 20 linkage groups representing 20 chromosomes (Chr) and to perform QTL analysis. Significant loci for TGW were identified on chromosomes 2, 8, 9, 11, and 13 with the best logarithm of odds (LOD) score of 5.06 on Chr 13 that explained 7% of phenotypic variation. Similarly, QTL for seed area were identified on chromosomes 2, 4, 8, 11, and 13 with the best LOD of 7.85 on Chr 2 that explained 10% of variation. The QTL regions identified in Chr 8 and Chr 13 for TGW and seed area include the MADS-box protein encoded by *FLOWERING LOCUS C*. Other genes identified within the 100 kb of markers with the best LOD scores in other chromosomes include leucine-rich repeat kinases and cysteine-rich proteins known to play a role in seed development. These results provide important information that will help our understanding of mechanisms involved in seed development and quality traits in camelina.

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DOUBLE CROPPING WITH EARLY MATURING WINTER CAMELINA

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Double and relay cropping short-season summer annual grain crops with winter camelina (*Camelina sativa* (L.) Crantz) are strategies to sustainably intensify food and bioenergy production. Both strategies are ways to attract farmer adoption of camelina for producing biofuel feedstock. In cool temperate continental climates, relay cropping can maximize production and economic returns, but is more management intensive than double cropping. Relay cropping is interseeding a summer annual into a primary winter annual standing crop in the spring such that their life cycles overlap for a brief period. Early maturing winter camelina has been identified for further development and might be harvested early enough to allow viable double cropping options even in cool temperate climates. A two-year field study in west central Minnesota, USA compared productivity, seed quality and seasonal water use of double cropping sunflower (*Helianthus annuus* L.), dry edible bean (*Phaseolus vulgaris* L.) and proso millet (*Panicum miliaceum* L.) after harvesting an early winter camelina line (EF-9). Also, winter survival, seed yield, and oil content were compared between EF-9 and Joelle winter camelina. The EF-9 matured 7 to 9 d earlier than Joelle with no significant yield difference, but lower oil content. Grain yields of double cropped dry bean and millet were as high as their monocrop counterparts, while sunflower was 20% lower but had similar oil content and quality to monocrop sunflower. Generally, double cropping used more water than the monocrops. Seasonal water use of double cropped sunflower was 102 mm greater than its monocrop check, which could limit its use in drier environments. Having viable double crop options like that with sunflower, dry beans, and millet might increase farmer adoption of producing camelina for industrial uses.

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SOWING STRATEGIES FOR CAMELINA IN THE MEDITERRANEAN REGION

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Camelina (*Camelina sativa* (L.) Crantz) is a novel oilseed crop for the European biobased industry. It is considered a low-input crop with a shorter growing cycle compared with rapeseed (*Brassica napus* L.) and carinata (*B. carinata* L.). It can be grown in most European climatic zones both as a winter and spring crop. Due to its short growing cycle and its cold resistance, it can be grown as a case cover crop in dry areas of South Europe. In the light of 4CE-MED project (www.4cemed.eu) camelina was studied as cash cover crop for the Mediterranean region (Italy, Greece, Spain, France, Morocco, Tunisia and Algeria) in cropping systems that have been adjusted to the area of its cultivation [a) for double cropping in South Europe (Greece, Italy and South France); two crops per year and b) as winter cover crop in rotation with winter cereals in north of Africa and Spain (using the fallow year between two growing seasons of cereals)]. Field trials have been carried out in all 4CE-MED countries for three subsequent growing seasons each and the tested factors were: sowing date (two per site; early and late), sowing density (600 and 800 seeds/m^2) and tillage systems (reduced till and no till). In all sites the tested camelina variety was ALBA provided by CCE company. In the majority of the field trials statistically significant differences had been recorded between the two sowing dates and plant densities. Camelina seed yields varied a lot among the project partners. In four (Greece, Italy, Morocco, and Algeria) out of the seven partners the late sowing gave higher seed yields compared to early one and in the rest of them the opposite happened (Figure A). Higher seed yields had been recorded in the plots with the high sowing density (800 seeds/m^2). In all sites camelina managed to grow well in no-till plots. All in all, after three years of experimentation in seven countries in the Mediterranean region it can be said that the best sowing date is the one that the farmers use to sow cereals. High seed density is needed (>6 kg seeds/ha; in 4CE-MED the best yields were measured when 8 kg seeds/ha were sown) in order for camelina to reach high seed yields (>1200 kg/ha). Last but not least, camelina had a successful cultivation in no-till plots in all field trials.

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ENHANCING SUSTAINABLE CAMELINA CULTIVATION THROUGH INTERCROPPING: A PATHWAY TOWARDS CLIMATE NEUTRALITY

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Climate neutrality by 2050 is the ultimate goal of the European Green Deal and it requires an increase in energy efficiency and significantly higher shares of energy from renewable sources in an integrated energy system. Camelina (*Camelina sativa* (L.) Crantz), a minor oilseed crop, has currently gained attention as feedstock for renewable diesel production for several reasons, such as it has high seed oil content (ranging from 30 to 42%), favourable fatty acid composition (significant amount of unsaturated fatty acids), relatively short growing season (up to 90 d), and requires minimal inputs such as water, fertilizer, and pesticides compared with some other crops. Camelina can be used as a rotational crop in agricultural systems, providing agronomic benefits to subsequent crops. Its deep root system helps break up compacted soil, improves soil structure, and reduces pest and disease pressure, thus contributing to overall agricultural sustainability. However, there is a restricted understanding regarding the possible yields of camelina cultivated within various intercropping systems. Intercropping is the simultaneous cultivation of multiple crops in the same area, and offers several benefits for sustainable agriculture, even under organic farming, as evidenced by literature. The aim of the study was to compare sole-camelina with camelina intercropped with pea (*Pisum sativum* L.), chickpea (*Cicer arietinum* L.), lentil (*Lens culinaris* Medik), and naked oat (*Avena sativa* L.) with respect to seed yield, oil content, and fatty acid composition. The field experiment was carried out during two growing seasons 2022-2024, at the organic experimental farm of the University of Bologna (Italy) in Ozzano dell'Emilia. The experimental design was a completely randomized block design with four replicates. Camelina was sown in two different trials: I) in winter sowing as sole-camelina (SCw) and intercrop with pes (ICp) and chickpea (ICc), whereas II) in spring sowing as sole-camelina (SCs) and intercrop with lentil (ICl), and naked oat (ICo). Sole-camelina was row-seeded at 8 kg ha^{-1}, while in the intercropping systems it was broadcasted at half of that dose (50:50). The harvest was carried out at the beginning of June for SCw and ICp, at the end of June for SCs and ICl, at the beginning of July for ICo and at the end of July for ICc. One way ANOVA was carried out for each trial (i.e. winter and spring). The first-year results showed that SCw produced higher seed yield than ICc but not than ICp, while SCs produced higher seed yield of ICo but not of ICl. Seed oil content in winter sown camelina was higher in ICp (30%) than SCw and ICc (average mean of 27.5 %). The fatty acid composition was affected by intercropping but the obtained differences were negligible. The second-year trial is currently ongoing and additional data will be available by the conference time. In conclusion, intercropping resulted in a sustainable way to cultivate camelina with pea and lentil without reducing seed yield and oil content. It might be possible to improve the camelina seed yield by reducing the seeding rate of the companion crop (i.e., chickpeas and naked oats), aiming at reducing their competition for available resources (i.e. soil and light) and thus promoting the growth of camelina.

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EFFECT OF FERTILIZATION SOURCE ON YIELD AND OIL QUALITY OF THREE CAMELINA VARIETIES

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Camelina [*Camelina sativa* (L.) Crantz] is a relevant oilseed crop to be integrated in the Mediterranean cropping systems. Its drought tolerance and the low input requirements render it interesting for farmers and stakeholders due to the scarce and irregular precipitation patterns and the marginal soils. Nonetheless, maximizing yields and enhancing the quality of the seed depending on the final objective, is necessary. The aim of the trial is to assess the impact of soil fertilization source on yield, seed oil content, and fatty acid (FA) profile in three spring camelina varieties. The trial was set in Montargull, in the semi humid Mediterranean region in northeastern Spain, during season 2022-23. The experimental design was a split-strip-block, with fertilization and variety as main factors. There were three fertilization treatments (compost, chemical, and pig slurry), applied at a rate of 50 kg N ha^{-1} two to three days before sowing, and a fertilizer-free control, in two blocks. On 15 November 2022, three camelina varieties (*Calena, CO46,* and *GP204*) were sown in strip plots, with three replicates. As a result, six plots for each fertilizer were assigned per variety. On 4 June, camelina was harvested with a micro harvester. After cleaning and drying, seeds were cold-pressed and the resulting oil was analyzed for FA profile by gas chromatography as FA methyl esters. The growing season was characterized by extreme dryness, with just 138 mm of precipitation recorded over the cycle, including a severe drought period during February, March, and April (12 mm throughout the three months). The drought affected negatively the yield of camelina, ranging from 949 to 1115 kg ha^{-1}. Although no significant differences were found across factors, *Calena* yielded the most with pig slurry, while *CO46* and *GP204* produced more with compost-based fertilization. Regardless of the variety, the fertilizer-free plots yielded the least. *CO46* had the highest seed oil content percentage (39%), whereas the pig slurry treatment resulted in a 2% lower oil content, on average, than the other treatments, including the control. Regarding the FA profile, *CO46* had significantly the lowest percentage of saturated (SFA) (9.7%) and polyunsaturated (PUFA) (55.2%) and the highest percentage of monounsaturated (MUFA) (35.1%). In addition, *CO46* was the variety with the highest concentration of omega-3 and the lowest of omega-6, 34.9% and 17.9%, respectively. These results can be attributable to the slower life cycle compared to the other varieties, which appears to lengthen the FA chains, increasing unsaturation. The pig slurry treatment stands out significantly from the other treatments with a higher percentage of MUFA and PUFA, mainly the omega-3. The fastest releasing of nitrogen of pig slurry treatment in comparison with the others appears to stimulate the fat synthesis. The experiment has been replicated in 2023-24 to see if the results are repeated.

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CAMELINA RESPONSE TO SALINITY FROM GERMINATION TO ROSETTE STAGE: PRELIMINARY IMPLICATION FOR MEDITERRANEAN REGIONS

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The expansion of salt-affected soils poses significant challenges for agriculture. This trend is particularly accentuated in Mediterranean regions, where soils which exhibit severe constraints to agriculture such as poor texture and sodicity, despite being classified as slightly or moderately saline. Typically, only cereals, especially barley (*Hordeum vulgare* L.) and sorghum (*Sorghum bicolor* L.), are grown in these lands, underlining the importance of diversifying agriculture in such areas through alternative crops, among which camelina, being a stress-proof crop. This study aimed to investigate camelina diversity in response to salt stress, both in vitro during germination and early root growth, and in vivo at the rosette stage. Seeds from 55 camelina accessions from different sources (i.e., gene banks and commercial materials) were incubated with a 200 mM NaCl solution in petri dishes. Germination rates were recorded at 24, 48, and 120 hours after sowing, revealing significant interactions between lines and salt treatment. Overall, the majority of tested camelina lines reported germination rates higher than 60% under saline conditions. Twelve lines with different behaviors in germination velocity, rates, and range of variation between control and saline treatment were selected for further investigation. These lines were incubated with a 200 mM NaCl solution on blue blotter germination paper substrate to observe early-stage root development. Measurements of root area at 6, 8, 10, and 13 days after sowing reported a significant effect of the interaction lines x treatment. Principal component analysis highlighted the complex nature of salt stress response in camelina, with no direct relation between root area and germination under saline conditions. Thereafter, three lines characterized by the highest, the lowest, and an average final root area under saline conditions were selected to investigate their morphological and physiological parameters at the rosette stage in a growth chamber experiment, simulating a spring sowing of camelina. The plants were grown in pots filled with a sandy sodic and slightly saline soil, taken from the northeast coast of Italy, in comparison with a control clay soil, which was neither saline nor sodic, taken from the northeast inland of Italy traditionally dedicated to agriculture. Pots have been maintained well-watered. Plant height, number of leaves, and average leaf growth rate were recorded weekly starting from seedlings emergence, while Chl fluorescence, net photosynthesis, stomatal conductance, and intercellular CO_2 were measured 45 days after sowing at rosette stage. Leaf growth rate and net photosynthesis were reduced under salinity in all camelina lines, while the line which reported the highest root area in the previous experiment showed an increase in intercellular CO_2 under saline treatment, suggesting morphological changes affecting mesophyll conductance or the activation of different biochemical path in its response to salinity. These findings emphasize the need for additional trials to identify and confirm the most significant parameters for screening salt tolerance in camelina, considering also seed production.

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REVEALING THE PHYSIOLOGICAL AND PRODUCTIVE RESPONSES OF CAMELINA TO DROUGHT STRESS

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Camelina is often recognized for its superior capacity to cope with drought compared with other oilseeds *Brassicaceae*, such as rapeseed (*Brassica napus* L.). In the frame of the UNTWIST project, funded by the European Commission (GA 862524), camelina response mechanisms to abiotic stresses (heat and drought) are thoroughly under study. Being many of the environments targeted for growing camelina in Europe characterized by drought (i.e., Mediterranean Europe, brown soils in the Saskatchewan region in Canada, etc.), occurring at different stages of the crop growth, a controlled environment trial was established in spring 2022 at Bologna University Experimental farm at Cadriano (Bologna, Italy). Four different camelina genotypes, characterized by different suitability to be grown around Europe and by diverse response to drought stress at early growth stage, were tested in a lysimeter station. The four genotypes were: UNT4 (from Camelina Company breeding program, Spain), UNT18 (the commercial variety Celine), UNT21 (from the collection of INRAe, France), and UNT46 (derived from the collection of ARS-USDA, Maricopa, USA). The four lines were sown in 24 lysimeters, (1 m^3 each) equipped with a drip-irrigation system, arranged under a transparent polyethylene tunnel. Half of them were kept under well-watered condition (WW), corresponding to 21% SWC (soil water content), and the remaining were subjected to drought stress (D= 9% SWC), imposed at camelina flowering start until maturity. Different responses in terms of plant morphology, physiology, biomass and seed yield were found. Interestingly, UNT46 showed an almost unique behavior being able to better cope with D than the other lines. From a physiological point of view, stomatal conductance under D of UNT46 was the lowest in the leaves but the highest in the silicles, compared with the other lines. At harvest, UNT46 seed yield was improved under D compared to its WW control, as well as to all the other lines in the trial. The degree of ^{13}C discrimination during photosynthesis is closely linked to the conductance of stomata. Open stomata and the free movement of water, ensures the free assimilation of CO_2, such that discrimination against ^{13}C is at its maximum, on the contrary closed stomata, which conserve water, restrict the availability of CO_2 and so ^{13}C discrimination is at its minimum. Analysing the ^{13}C in the straw and seed at harvest revealed that for seeds, it was possible to discriminate only between D and WW plants and not among lines, while for straw UNT46 and UNT21 resulted less impacted by D reporting a higher ^{13}C discrimination. Interestingly, correlation between seed ^{13}C and seed yield resulted not significant, while that between straw ^{13}C and biomass yield was highly significant ($P \leq 0.05$, r=-0.72), suggesting that stomatal limitation occurring under D is directly related to biomass formation but seed production in camelina is a more complex process including many enzymes involved in oil biosynthesis.

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DO NITROGEN RATES AFFECT CARBON INTENSITY IN SPRING AND WINTER CAMELINA?

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Camelina (*Camelina sativa* (L.) Crantz) has been selected as one of the potential low carbon intensity feedstock for sustainable aviation fuels (SAF) in the USA and Europe. Camelina does require much fewer external inputs than other oilseed feedstocks, such as rapeseed (*Brassica napus* L.), but it also yields about half of other commonly grown oilseed crops. The objective was to determine the carbon intensity (CI) of spring and winter camelina with varying rates of nitrogen fertilizer (0, 20, 40, 60 and 80 kg/ha). The spring camelina cultivar New Gold™ was planted on May 22, 2023 and the winter camelina, cultivar Joelle on 28 September, 2023 in Fargo and 2 October, 2023 in Prosper, ND. The design was a randomized complete block with four replicates. Carbon intensity was estimated using a life cycle assessment (LCA) methodology from 'cradle to farm gate'. Spring camelina seed yield was 1432 kg/ha at the highest N rate of 80 kg N/ha in Fargo. In Prosper, seed yield (1531 kg/ha) was the highest at the 50 kg N/ha rate. Carbon intensity of seed ranged between 23 and 76 g CO_2 eq./MJ. Lowest CI was with a N rate of 40 kg N/ha at Prosper. Carbon intensity decreased as N rates increased until a rate of 51 kg N/ha for the combined CIs across both locations (r^2= 0.95). This indicates that the increase in seed yield by increasing the N rate can offset the increase in CI due to N fertilizer and N_2O field emissions. Camelina aboveground residue after harvest was 4-5 Mg/ha and had 43.8% C and 0.92% N concentration. Carbon contribution to the soil from the aboveground biomass was 1.5-2.0 Mg/ha/year. Winter camelina yield and carbon intensity responses will be presented at the conference. Camelina can be a low CI crop but it depends on seed yield obtained and N fertilizer rate applied.

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MECHANISMS OF HYDROXY FATTY ACID BIOSYNTHESIS IN LESQUERELLA (*PHYSARIA FENDLERI*)

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The conventional source of hydroxy fatty acid (HFA) is castor (*Ricinus communis* L.) oil which contains 90% ricinoleic acid (18:1OH) of total fatty acids in seed. HFA and its derivatives are used as raw materials for numerous industrial products, such as lubricants, plasticizers and surfactants. The production of castor oil, however, is hampered by the presence of the toxin ricin and hyperallergic 2S albumins. Lesquerella does not have such biologically toxic compounds and also contains a major HFA, lesquerolic acid (20:1OH), at 55-60% of seed oil. Therefore, lesquerella is being developed as a new industrial oilseed crop in the US. Synthesis of 20:1OH is through elongation of 18:1OH, and the step is regulated largely by gene transcription of an elongase, PfKCS3. By silencing *PfKCS3*, transgenic lesquerella increased 18:1OH content from ~3% to ~27%. It is known that most of the HFAs in lesquerella are located only at *sn*-1 and *sn*-3 positions of triacylglycerols (TAG). To improve HFA levels in lesquerella seeds, castor *lysophosphatidic acid acyltransferase* gene 2 (*RcLPAT2*) has been introduced into lesquerella. The resulting transgenic lesquerella seeds increase 18:1OH content at the *sn*-2 position of TAG from 2% to 17%, and consequently, oil accumulates more TAGs with all three *sn* positions occupied by HFA. The results enhance our understanding of plant lipid metabolism and provide guidance for future research. Recent study reveals that lesquerella oil biosynthesis utilizes a new triacylglycerol (TAG) remodeling mechanism. TAG remodeling involves a unique TAG lipase and two diacylglycerol acyltransferases (DGAT). DGATs and TAG lipase can increase HFA accumulation in engineered seed oils.

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COMMERCIALIZATION OF PENNYCRESS (*Thlaspi arvense* L.) AS A SUSTAINABLE AVIATION FUEL SOURCE

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The conversion of *Thlaspi arvense* L. (Field Pennycress; pennycress) into a winter-annual oilseed crop presents an opportunity to integrate cover crop benefits into the agricultural landscape. This presentation summarizes efforts to commercialize pennycress to meet the Biden administration's Sustainable Aviation Summit Sustainable Aviation Fuel (SAF) Grand Challenge. This initiative involves government agencies collaborating to scale up technologies for SAF production. Goals include producing 1.63 billion liters per year by 2030 and meeting 100% of U.S. aviation fuel demand by 2050. Marketed as CoverCress™ by CoverCress Inc. (CCI), domesticated pennycress product offers potential for up to 1 billion liters of seed oil annually by 2030, with broader implications for the aviation sector's quest for carbon-neutral growth. The interdisciplinary IPREFER (Integrated Pennycress Research Enabling Farm and Energy Resilience) Project funded by a $10 million USDA-NIFA grant, aims to remove production bottlenecks and commercialize domesticated pennycress. Collaborating with academic institutions, USDA-ARS, and CCI, the project spans agronomic studies across four Midwestern states, focusing on yield enhancement, gene editing, crop management, and post-harvest handling. Additionally, the US Department of Energy $13 million grant IPReP (Integrated Pennycress Resilience Project) is focused on using natural and induced variation in pennycress to improve abiotic stress tolerance in pennycress for a changing climate. Both projects have contributed tremendously in getting pennycress in production. Pennycress's potential as a biofuel feedstock aligns with the aviation industry's commitment to carbon-neutral growth. Amidst increasing global air travel demand and escalating CO_2 emissions, the aviation sector is embracing sustainable aviation fuel as a key solution. Pennycress's role in SAF production offers a pathway to mitigate aviation's environmental impact while fostering economic opportunities and environmental stewardship in agricultural communities. Through collaborative research and market-driven initiatives, the journey from 'farm to flight' underscores the transformative potential of biofuels in shaping a greener future for aviation and agriculture alike.

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GENETIC DIVERSITY AND POPULATION STRUCTURE OF THE USDA SESAME ACCESSIONS

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Sesame, *Sesamum indicum* L., is one of the oldest domesticated crops. Sesame is planted as a source for oil and protein in many parts of the world. Sesame seed oil, protein and other nutrients make it a good source for healthy food products. To build genomic resources for sesame that could be used to improve sesame productivity and responses to stresses, a diversity panel consisting of 501 USDA sesame accessions was designed to include accessions collected from 36 countries. The panel was genotyped using genotyping-by-sequencing (GBS) technology to explore its genetic diversity and population structure and the relatedness among its accessions. A total of 24,735 high-quality single nucleotide polymorphisms (SNP) markers were identified. Those SNP were distributed over the 13 chromosomes with an average of 1900 SNP per chromosome, an average polymorphism information content (PIC) value of 0.267 and an expected heterozygosity (He) value of 0.332. Those marker polymorphisms and heterozygosity estimators indicated the usefulness of the identified SNP to be used in future genetic studies and breeding activities. Population structure, principal components analysis (PCA), and unrooted neighbor-joining phylogenetic tree analyses classified two distinct subpopulations, indicating the wide genetic diversity within the USDA sesame collection. Analysis of molecular variance (AMOVA) revealed that 29.5% of the variation in USDA sesame collection was among the two subpopulations, while 57.5% of the variation was due to the variation among accessions within subpopulations. These results showed the degree of differentiation between the two subpopulations as well within each subpopulation. High fixation index (F_{ST}) between distinguished subpopulations indicates a wide genetic diversity and high genetic differentiation among and within identified subpopulations. Linkage disequilibrium (LD) pattern averages 161 Kbp for the whole sesame genome, while the LD decay varied across the 13 sesame chromosomes with 123 Kbp in chromosome LG05 to 168 Kbp at chromosome LG09. Those findings could explain the complications of linkage drag among traits during selections. The selected accessions and genotyped SNP provide tools to enhance genetic gain in sesame breeding programs through genome-wide association analysis studies (GWAS) and marker-assisted selection (MAS) approaches.

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CHARACTERIZATION OF FRACTIONS OF CASTOR MEAL SEPARATED BY PARTICLE SIZE

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Castor meal is the main by-product of the extraction of oil from castor seed (*Ricinus communis*). This material is rich in nitrogen, and it has been traditionally used as organic fertilizer because of the presence of ricin, a very toxic protein. There is some progress in the detoxification of castor meal aiming its use as feed for ruminant animals, and this new use will add relevant value for the castor supply chain. The composition of castor meal is influenced by the quality of the raw material that enters the process. In general, the seed delivered to the industry contains a significant amount of castor fruit husks because the cleaning made by farmers is inefficient. The process of oil extraction consists of a sequence of heating, press-expelling, and solvent extraction, and it basically extracts the oil, leaving in the meal everything that came with the seeds. There is large variability in the composition of the meal reflecting the variations in the quality of the raw material entering the process. The objective of this study was to separate castor meal in fractions according to the particle size to quantify the variability of each particle in the composition. The study was made in 18 samples of castor meal collected in an industry of castor oil extraction in the State of São Paulo, Brazil. The material was passed in several sieves with openings varying from 12.5 to 0.045 mm. The particles retained in each sieve were weighed. The particles were photographed in a microscope for observing the main aspects of each fraction. It was observed that the composition of the fractions was clearly different. The largest particles (> 4 mm) correspond to 24% of the castor meal weight, and they are predominantly composed of clods created by the pressure applied in the expelling press. The fractions between 4 and 2.0 mm correspond to 20% of the weight, and they are predominantly composed of fragments of fruit husks. The particles between 1 and 2 mm correspond to 26% of the weight, and they are composed of fragments of seed coat. Particles smaller than 1 mm correspond to 30% of the weight, and they are fragments of the internal parts of the seed. It is proposed that the industry of oil extraction could separate castor meal in fractions according to the particle size, and each material could have different uses. The clods formed in the pressing phase can be grinded to reduce the particle size. The fragments of fruit husk and seed coat are a fibrous material with better use for burning or as organic fertilizer. The fragments of the internal parts of seed contain most of the crude protein, and they are the most valuable as ruminant feed or high-nitrogen fertilizer. This study will be continued with deeper chemical characterization of the and biological properties of each fraction.

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LONG-TERM SCREENING TRIALS FOR CASTOR BEAN IN GREECE

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Castor bean (*Ricinus communis* L.) is a valuable oilseed crop due to its richness in ricin oleic acid (>80%) having numerous chemical and medicinal applications. More than 3 million hectares are being cultivated annually at world level. It is mainly cultivated in India where it is harvested manually. Recently, castor bean has been selected by MIDAS project (www.midas-bioeconomy.eu) as high yielding non-edible oilseed with low inputs that can successfully grow in marginal lands facing natural constraints. For more than one decade screening trials are being carried out in central Greece where high yielding hybrids have been compared with high seed yields that will be presented in this research work. A large number of castor bean hybrids have been compared: Kaiima 71, Kaiima 75, Kaiima 93, C854, C855, C856, C857, C864, C1002, C1008, C1012, C1013, C1015, C1016, C1018, C1019, C1020, C1033. The screening trials had been carried out in 2011, 2012, 2014, 2015, 2016, 2017, 2019, 2021, 2022, 2023. In total 10 field trials had been carried out testing in total 18 hybrids. The sowing of all trials carried out from mid-April till mid-May and the targeted plant density was 6 plants/m^2 (the distances between the rows in the majority of the fields were 70 cm). The size of each plot varied from 20 to 30 m^2. A drip irrigation system was established. Before sowing a basic fertilization was applied (250-300 kg/ha of 11-15-15), while 30 to 40 days after sowing a nitrogen fertilization was applied through the drip irrigation (50-60 kg N/ha). No diseases or pests had been recorded in the field trials. No herbicides were applied to stop the growth of the crop and the final harvest was organized from mid-September to mid-October depending on the climatic conditions of each growing period. At the final harvest a 2 m^2 per plot was harvested to estimate the seeds and straw yields. The harvested biomass was weighed and then separated to stems, leaves and racemes (the seeds have been manually collected from the racemes). At the final harvest the plant height, the number of racemes per plant and capsules per raceme as well as number of green racemes per plot had been measured. In the majority of the fields and hybrids the seed yields were quite high and came up to 4.27 t/ha. The mean seed yields averaged overall trials and years was 3.16 t/ha. Seeds samples had been selected for oil content analysis, while samples from leaves and stems have been also selected, oven-dried and milled for their biomass characterization (calorific value, proximate and elemental analysis). The oil content of the seeds varied from 45 to 50%. The gross calorific value was 4200 kcal/kg for leaves and 4260 kcal/kg for stems. The corresponding values for ash content were 7.2% and 11.4%.

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PHYSICAL, CHEMICAL, AND THERMAL PROPERTIES OF *Orychophragmus violaceus* SEEDS AND OIL

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Orychophragmus violaceus (Brassicaceae; common names: Chinese violet cress, February orchid) is widely distributed in northern and eastern China both as an annual and perennial plant. *O. violaceus* (Ov) is commonly used for erosion control and as an ornamental plant. The seed is rich in oil containing the very long chain dihydroxy fatty acids nebraskanic [7,18-(OH)2-24:1Δ] and wuhanic [7,18-(OH)2-24:2Δ] acids. It has been reported that the oil is accumulated in the seed as natural triacylglycerol (TAG) estolides. We report on the properties of Ov seeds and solvent-extracted oil. Based on thousand seed weight (TSW), Ov seeds (3.1 g) are larger than camelina (0.96-1.81 g) but smaller than rapeseed (~5.1 g). Ninety five percent of the seeds were retained on a 16 mesh (1.18 mm) screen. The bulk density (591 g/L) was lower than those of camelina (636 - 666 g/L) and rapeseed (623 g/L). The seed's true density was 1.14 g/cm^3, hence the seed bed had a porosity (space between seeds) of 48%. The seed contained 44.3% oil and 23.9% protein on a moisture-free basis. No oil was recovered by cold-pressing the seed, but 39% crude oil was obtained from the press cake after 2 h of hexane extraction. The green-colored oil (CIE L a*b* = 41.9, 0.4, 70.8, respectively) contained 51 ppm chlorophyll and had an acid value of 6.6 mg KOH/g. The density of the oil at 15°C was 0.954 g/mL, heavier than most vegetable oils (≤ 0.930). The oil exhibited a high oxidation onset temperature of 180°C. Thermogravimetric analysis under nitrogen showed 10% mass loss when the temperature reached 333°C. The high viscosity index (VI) of Ov oil (133) indicated good stability over a wide temperature range which is desirable in lubricant applications. Other natural hydroxy oils, like castor bean (*Ricinus communis* L.) and lesquerella (*Physaria fendleri* L.), have VIs of 89 and 123, respectively. The favorable properties of the seed and oil make Ov a prime candidate for domestication as an industrial oilseed crop.

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ABSTRACTS

ORAL PRESENTATIONS

MEDICINAL AND NUTRACEUTICALS DIVISION

CHAIR

VALTCHO D. ZHELJAZKOV

DEPARTMENT OF CROP AND SOIL SCIENCE

OREGON STATE UNIVERSITY

HARNESSING NATURE'S REMEDIES FOR A GREEN TOMORROW; THE ROLE OF MEDICINAL AND AROMATIC PLANTS

Laura De Martino[1], Daniela Grul'ová[2], Lucia Caputo[1], Hazem S. Elshafie[3], Beáta Baranová[2], Carmen Formisano[4], Janka Poráčová[5], Ippolito Camele[3], Filomena Nazzaro[6], and Vincenzo De Feo[1,6]

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The growing global demand for sustainable and eco-friendly solutions has renewed interest in the potential of medicinal and aromatic plants (MAPs) to address a wide range of health and environmental challenges. These natural resources offer a treasure trove of bioactive compounds with diverse therapeutic and nutraceutical applications. Research has identified potent antioxidants like rosmarinic acid from rosemary with applications in managing oxidative stress-related diseases. Additionally, antimicrobial essential oils from plants like thyme, oregano have been characterised. Anti-inflammatory compounds, such as boswellic acids and withanolides have also been evaluated for managing chronic inflammatory conditions. Strategies have been developed for the sustainable cultivation of *Artemisia annua* L., the source of the antimalarial drug artemisinin, while efforts to conserve endangered medicinal plants like *Panax ginseng* C.A. Mey. are being pursued through germplasm banks and controlled cultivation. Additionally, phytopharmaceuticals containing standardised extracts of MAPs, such as *Gingko biloba* L. for cognitive enhancements and *Hypericum perforatum* L. for mood regulation, are becoming increasingly popular. By addressing regulatory hurdles and quality control issues, future research in areas like metabolic engineering and nanotechnology aims to improve the bioavailability and efficacy of MAP-derived compounds. Notably, it has been discovered that the essential oil from the invasive Canadian goldenrod (*Solidago canadensis* L.) and its constituents like anethole and estragole can suppress seed germination, demonstrating the potential of MAPs as eco-friendly pest control agents. The presentation will highlight the latest scientific evidence and case studies to demonstrate the immense potential of MAPs in creating a more sustainable and healthier world.

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NATURAL PRODUCTS FOR CONTROL OF SPROUTING IN POTATO

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The potato (*Solanum tuberosum* L.) is the most important non-cereal staple crop vital for improving global food security and alleviating hunger. Dormancy in potatoes is a growth suspension state in response to stress. Breaking this dormancy leads to sprouting, which affects the potato's weight, texture, nutrition and can lead to the formation of harmful alkaloids. Historically, chlorpropham (CIPC) has been used to control sprouting due to its effectiveness and cost-efficiency. However, due to health and environmental concerns, the EU recently banned CIPC. Our goal is to discover and develop essential oil (EO)-based products for potato sprout control. A study was conducted to evaluate 30 EOs and EO fractions for control of potato sprouting. The experiment was conducted at room temperature, for 30 days. The potatoes were placed in 20-L plastic containers and the EOs were applied to a cotton ball in a Petri dish. Therefore, the potatoes were exposed to the EO vapors in the container without directly touching the potato tubers. The sprout length and tuber weight loss were evaluated relative to a control without EO. Overall, peppermint (*Mentha piperita* L.) EO (from two different sources), provided the best control of potato sprouting with zero sprouting over 30 days. The next most effective treatments were provided by the EO of clove (*Syzygium aromaticum* L.), common rue (*Ruta graveolens* L.), Eau de Cologne mint (*Mentha citrata* Ehrh.), and American wild mint (*Mentha canadensis* L.). However, some of the EO stimulated sprouting relative to the water control. This study identified several EOs whose vapors can suppress or reduce potato sprouting at room temperature over a period of 30 days.

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THE EFFICACY OF ESSENTIAL OIL BLENDS AS POTATO SPROUT SUPPRESSANT AND NATURAL ANTIMICROBIAL AGENTS

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Managing potato sprouting during storage presents significant challenges, leading to food wastage and economic losses. Essential oils (EOs) have shown promise as sprout suppressants, yet their effectiveness varies based on EO type, concentration, and storage conditions. Our preliminary experiments indicated sprout suppressant properties in *Lavandula* x *intermedia*, *Cinnamomum camphora*, and *Origanum majorana*. These EOs were selected to study their individual and synergistic effects on inhibiting potato sprouting in Ranger Russet, La Ratte, and Norkotah minituber cultivars stored at room temperature. An optimal EO blend for suppressing potato sprouting was identified that effectively minimized both sprout length and number throughout the entire 90-day storage period. The study also compared the EOs' sprout suppression activities with clove EO, the only EO currently registered for potato sprout control in the United States. The findings showed that both the individual EOs and their mixture applications were superior in suppressing sprouting compared to clove EO. Furthermore, the study revealed that these EOs possess antifungal properties against potato late blight (*Phytophthora infestans*), indicating their potential as natural fungicides. Additionally, the EOs exhibited inhibitory effects on ten different microbial strains including Gram-positive, Gram-negative bacteria and yeasts from *Candida* genus, highlighting their promising capabilities as antimicrobial agents. These results suggest that EO blends could serve as a viable organic alternative to chemical sprout suppressants, offering dual functions as both sprout suppressants and fungicides, thereby providing sustainable solutions for the potato industry and beyond.

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ESSENTIAL OILS TO SUPPRESS POTATO SPROUTING AT ROOM TEMPERATURE

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Potatoes (*Solanum tuberosum* L) are a staple food crop that feeds millions of people worldwide. The quality of stored potatoes plays an important role in ensuring stable food supplies throughout the year. However, potato sprouts emerging during storage pose a major challenge, resulting in reduced product quality and reduced nutritional value. Chemical agents, such as (chlorpropham or CIPC), have long been used to combat potato sprouts. However, these chemicals are raising increasing concerns about their safety for human health and the environment. Essential oils (EOs) offer a promising natural alternative to combat potato sprout growth. Essential oils are characterized by their complex composition, containing organic compounds such as alcohols, terpenes, and aldehydes. These compounds offer a broad combination of biological properties, offering enormous anti-sprout potential. Mixtures of several EOs can achieve better anti-sprout properties given the synergistic interactions between the organic compounds. Several research studies are currently being conducted to evaluate the effectiveness of EOs and their mixtures in combating potato sprouts. In this study, we evaluated three essential oils (EOs #169, #184, and #223), both individually and in various mixtures, as sprout suppressants for potato cultivars Ranger Russet, La Ratte, and Norkotah (the latter as minitubers) stored at room temperature. Essential oils #184 and #223 were effective when used alone, successfully suppressing sprouting over a 90-day storage period. The interaction between EOs #184 and #223 influenced both sprout length and number. These results are promising, indicating the potential of these essential oils as a natural and effective alternative to chemical agents.

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PHYTOTOXIC EFFECTS OF SESQUITERPENE LACTONES ENRICHED FRACTIONS AGAINST WEEDS AND ITS POSSIBLE USE AS A BIOHERBICIDE

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Sesquiterpene lactones (SL) are allelopathic compounds with high expression in cardoon (*Cynara cardunculus* L.) leaves (≈ 95g/kg dry weight). Due to their wide-ranging phytotoxic activity, SL are a promising option as bioherbicides in sustainable weed management. The aim of this study was to assess the phytotoxic potential of SL-enriched fractions, obtained in a previous study by our research group, against a panel of Mediterranean weed species in pre-emergence, as well as on the post-emergence state of common purslane (*Portulaca oleracea* L.). For that experiment, cardoon leaf initial extract, SL-enriched fractions and a commercial herbicide were tested at concentrations ranging from 100 and 800 ppm against a panel of eight weed species. After incubation, germination rate, root and shoot length were evaluated. For common purslane post-emergency bioassay, cardoon leaf initial extract, SL-enriched fractions and a commercial herbicide were tested, in a hydroponic system, at 800, 600 and 400 ppm. After a 12-day trial, the plants were harvested, and phytotoxic potential was assessed by measurements of malondialdehyde (MDA), total chlorophyll content, and superoxide dismutase inhibition activity. Results demonstrated that cardoon leaf initial extract and SL-enriched fractions had inhibitory effects on the weed panel used, especially on root growth. Furthermore, SL-enriched fractions inhibited root growth more effectively than cardoon leaf initial extract on 6 of the 8 weed species tested. Regarding the post-emergence bioassay, SL-enriched fractions had a higher influence on total chlorophyll content with a decrease of 65.24%. Oxidative stress was also induced, as proved by the enhancement of MDA levels in comparison with control (51.94%) and the decrease in specific activity of SOD. This study demonstrated the effectiveness of SL-enriched fractions on root growth inhibition of several weed species in their pre-emergence stage. Also, SL effects on plant metabolism were evidenced by affecting chlorophyll content and inducing oxidative stress. Preliminary studies for a formulation design have been performed, considering type, extract stability in solution and ecological excipients.

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ALTERNATIVE TECHNOLOGIES FOR THE EXTRACTION OF β-CAROTENE FROM *Rhus microphylla* FRUIT

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Plants serve as abundant sources of natural pigments, providing vibrant colors to fruits and vegetables while fortifying them against various environmental stresses. Natural pigments offer manifold health benefits, including antifungal, antimicrobial, antioxidant, and anticancer properties, contrasting with the adverse health effects of synthetic dyes. This study explores novel extraction techniques, employing microwave-assisted extraction alongside eutectic solvents, to obtain extracts from *Rhus microphylla* fruits. Previous research suggests that *Rhus* species host a range of desirable bioactivities, from antifibrogenic to hypoglycemic. Preliminary extractions compared two eutectic mixtures (CHCl-acetic acid-water, and CHCl-glycerol-water), assessing total phenol content (TPC), total flavonoid content (TFC), and antioxidant activity by the DPPH (2,2-diphenyl-1-picrylhydrazyl), ABTS (2,2'-azino-bis (3-ethylbenzthiazo-line-6-sulphonic) diammonium acid), and FRAP (ferric reducing antioxidant power) assays. A multivariate experimental design, incorporating temperature, extraction time, and water percentage variables, yielded optimal conditions at 180°C for 24.95 min with 42% water in CHCl-glycerol solvent. This yielded significant results, with TPC: 52.9 ± 0.9 mg gallic acid equivalents/g extract), TFC: 26.1 ± 0.4 mg rutin equivalents/g extract, and antioxidant activity (DPPH: 129.6 ± 8.8, ABTS: 195.5 ± 5.9, FRAP: 166.5 ± 3.2 mg Trolox equivalents/g extract). Spectrophotometric analysis of β-carotene content in the optimal extract revealed 5.0 ± 0.4 mg total β-carotene/g extract. This study reveals, for the first time, the potential for enhancing yields through innovative extraction methods, emphasizing the importance of exploring the bioavailability and pharmaceutical applications of medicinal plant resources.

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PHYTOCHEMICAL COMPOSITION AND BIOACTIVE PROPERTIES OF EXTRACTS FROM *Eysenhardtia texana* USING CONVENTIONAL AND DEEP EUTECTIC SOLVENTS

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Eysenhardtia texana, commonly known as "Palo dulce" or "Riñón de Texas", belongs to the Fabaceae (legume) family and thrives in arid and semi-arid regions of Mexico and southern Texas. Traditionally utilized by the Kikapú community to alleviate kidney issues, the properties of this species remains relatively underexplored. This study aims to assess the effects of both conventional and unconventional solvents, including Deep Eutectic Solvents (DES), on the recovery of extracts from leaves and branches. Conventional solvents tested include HA (hydroalcohol), A (aqueous), and EE (ethanol), while non-conventional solvents encompass DES1 (4:1 citric acid + glycerol), DES2 (4:1 sodium acetate + glycerol), DES3 (6:1:6 lactic acid + D-glucose + water), DES4 (3:1:2 lactic acid + sodium acetate + water), and DES5 (1:1:10 acetic acid + choline chloride + water). Extraction employed a conventional agitation method at 50°C for 2 h at 150 rpm. The characterization of extracts included total phenolic content (TPC), total flavonoid content (TFC), and antioxidant activity by DPPH (2,2-diphenyl-1-picrylhydrazyl) and 2,2'-azino-bis(3-ethylbenzthiazo-line-6-sulphonic) (ABTS) methods, along with *in vitro* antifungal activity against *Aspergillus niger*. With respect to TPC, DES extractions from leaves exhibited higher content compared to conventional solvents, with values ranging from 17.5±1.8 mg GAE (gallic acid equivalents)/g to 20.9±2.4 mg GAE/g. Conversely, branches showed notable TPC in DES3, DES4, and DES5 extracts (ranging from 18.8 mg GAE/g to 20.93 mg GAE/g), while EE extracts displayed the lowest content (8.0±0.9 mg GAE/g in leaves and 4.5±0.7 mg GAE/g in branches). Regarding TFC quantification, DES2 and DES3 extracts demonstrated higher content in leaves (40.2 ± 5.7 mg Quercetin Equivalents QE/g and 44.6 ± 3.61 mg QE/g, respectively), while HE extracts showed higher content in branches (29.4 ± 2.1 mg QE/g). Antioxidant activity varied across solvent types and plant parts, with DES2 extracts showcasing notable activity in leaves (92.7±4.9 mg Trolox equivalents (TE)/g with DPPH and 106.3±5.2 mg TE/g with ABTS). *In vitro* antifungal activity tests revealed 100% inhibition rates across all concentrations evaluated (0.5%, 5%, and 20%) for DES extracts, while conventional solvents showed no inhibition in any treatment. This study exhibits the potential of DES in extracting bioactive compounds from *E. texana*, suggesting promising applications in various industries.

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ESSENTIAL OIL VARIABILITY OF NATURAL POPULATIONS OF *SATUREJA SUBSPICATA*

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Satureja subspicata Bartl. ex Vis. is an endemic species distributed along the Balkans Dinaric mountains and the eastern region of the Apeninic peninsula. *S. subspicata* is an aromatic and medicinal plant used in traditional medicine as a remedy for cardiovascular disorders and respiratory system inflammation. Also, this is a nectariferous plant species rich in specialized metabolites with antimicrobial and antioxidant properties. Honey produced from *S. subspicata* also possesses medicinal properties. These applications are based on plants' chemical profiles, particularly essential oil (EO) composition. Individual EOs were isolated by simultaneous hydrodistillation and extraction (SDE) method from nine natural populations, including both subspecies ssp. *liburnica* (five populations) and ssp. *subspicata* (four populations). Studied natural populations inhabit open rocky and arid habitats in the Submediterranean zone at higher altitudes. GC/MS and GC-FID analyses detected 154 compounds in total. However, 40-83 compounds were detected in different populations, which is 89-98% of total EO content. The essential oil profile is characterized by several compounds with higher percentages (13-31%) rather than one main compound (over 50%). In most populations, two sesquiterpenes and one monoterpene were in higher quantities (*E*)-caryophyllene, caryophyllene oxide, and *α*-pinene. Multivariate analysis of EO profiles showed a clear separation of these subspecies and a lower population differentiation. These results suggest that the phytochemical profile of the EOs has a different geographical distribution, which means the selection of localities for beekeeping, cultivation, or collecting plants is significant since the quality of the final product depends on the chemical composition of the source plant material.

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PLA-CURCUMIN BIOPOLYMERS: SHINING A LIGHT ONTO POTENTIAL PHOTODECONTAMINATING MATERIALS

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The successful management of infectious diseases by multi-drug resistant (MDR) bacteria remains one of the greatest health and technological challenges. Indeed, MDR bacteria are already responsible for more than 1.3 million annual deaths. One of the main causes of the spread of MDR bacteria are contaminated hospital surfaces and medical devices; therefore, the development of suitable disinfection methodologies should be on the frontline for the prevention of infections. Current surface disinfection approaches rely on ethanol, hydrogen peroxide, bleach, UV-light, phenols, ozone, and quaternary ammonium salts, but none represent an ideal solution for this issue due to volatility, narrow microbicide spectrum, toxicity/corrosiveness and resistance development. An alternative strategy is the use of biodegradable polymers, such as polylactic acid (PLA) embedded with natural-based photosensitizers (PS). These photosensitizers, through exposure to light of specific light wavelengths can generate reactive oxygen species, capable of inactivating bacteria - a technique known as photodynamic inactivation (PDI). We developed PDI-based photodecontaminating material, where the natural and non-toxic photosensitizer, curcumin, were incorporated into a PLA matrix. Through solvent casting method, we produced thin PLA films containing curcumin loads of 15%, which were subsequently characterized using various techniques including differential scanning calorimetry (DSC), thermogravimetry (TG), polarized light thermomicroscopy (PLTM), fourier-transform infrared spectroscopy (FTIR) and X-Ray powder diffraction (XRPD). These analyses provided valuable insights into the semi-crystalline nature of the materials. Moreover, our findings demonstrate the promising antimicrobial efficacy of these films against the bacterium *Staphylococcus aureus*, achieving up to a 99.99% reduction following irradiation with a blue LED (32.9 J/cm^2). The films also showed potential as food packaging, preventing the development of fungi on raspberries when irradiated with white light. Combined with their favorable physicochemical properties, these PLA-Curcumin films exhibit significant potential as next-generation photodecontamination materials capable of curbing the spread of microorganisms through contaminated surfaces.

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ANTIFUNGAL ACTIVITY OF EXTRACTS FROM PLANTS OF THE SEMIARID ZONES AGAINST *Alternaria tenuissima*, *Fusarium oxysporum*, AND *F. solani*, ISOLATED FROM PEACH TREES

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In recent years, peach production has been negatively affected by diverse phytopathogenic fungi. Traditionally, agrochemicals has been used to control these pathogens; however, their excessive use could generate serious environmental problems. In recent years, the use of plant extracts to control pathogenic fungi has been investigated. This study focuses on evaluating the antifungal activity and antioxidant capacity of leaves extracts from *Larrea tridentata* (Lt), *Lippia graveolens* (Lg), and a combination of *Rhus muelleri* and *Flourensia retinophylla* (RF) extracts, obtained through ultrasound-assisted extraction (UAE). The phytochemical composition was evaluated, including the total phenolic and flavonoid contents (TPC and TFC, respectively), condensed tannins (CT), and alkaloids (ALK). Additionally, the antioxidant capacity was measured using the DPPH, ABTS, and FRAP methods. The antifungal activity was analyzed *in vitro* against three fungi *Alternaria tenussima*, *Fusarium oxysporum*, and *F. solani*, isolated from peach trees in Zacatecas, Mexico. A total of 17 concentrations (100 to 7000 mg/L) were tested, along with absolute and chemical controls. The data obtained were subjected to analysis of variance under a completely randomized design, and the means were compared using the Tukey test ($p \leq 0.05$). The results indicated that the Lt extract showed the highest values of TPC, CT, and ALK. Moreover, the Lg extract presented the highest TFC content, and RF stood out for its high antioxidant capacity. Regarding antifungal activity, RM at a concentration of 7000 mg/L completely inhibited the mycelial growth of the three studied fungi. In conclusion, the evaluated extracts demonstrated significant antifungal activity against the analyzed pathogens, positioning them as promising alternatives to traditional agrochemicals.

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SCUTELLARIA: BIOACTIVE COMPOUNDS, MEDICINAL PROPERTIES, AND BIOECONOMY PROSPECTS

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Scutellaria species (common name skullcap) are known for their valuable contribution to nutritional benefits along with health-promoting bioactive compounds. These qualities are due to the presence of vitamins, minerals, and various phenolic ingredients. *Scutellaria* genus with about 400 species, cosmopolitan by habitat, are known for the presence of serotonin and melatonin, in addition to flavonoids, steroids, alkaloids, and tannins. Various *Scutellaria* species serve as a local remedy to treat anxiety, cancer, cirrhosis, hepatitis, and neurological problems. The most prominent compounds isolated from *Scutellaria* species are with antioxidant, analgesic, laxative, diuretic, anti-diabetic, anti-allergy, anti-inflammatory, and anti-tumor properties. The American skullcap has been used for more than 200 years as a mild relaxant and as a therapy for anxiety, nervous tension, and convulsions. Studies show American skullcap has significant antioxidant effects, and may help protect against neurological disorders, such as Alzheimer's disease, Parkinson's disease, anxiety, and depression. Most of the studies done on skullcap have examined Chinese skullcap in traditional Chinese medicine to treat allergies, infections, inflammation, cancer, and headaches. It may also have antifungal and antiviral effects as suggested by some researchers. Animal studies indicate that Chinese skullcap may help reduce symptoms of diabetes and hypertension (high blood pressure), but scientists do not know if Chinese skullcap has the same effect in humans. American skullcap including *S. baicalensis*, and *S. barbata* have been used for herbal tea and supplements and may be combined with other calming herbs in some preparations. There are a few studies that have indicated overall immune system improvement when skullcaps were used in animal feed. Many species have showy flowers so they can be an addendum to the floriculture. All these features make skullcaps a lucrative commercial crop.

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EXPLORING CROPS FOR FOOD PACKAGING APPLICATIONS

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The widespread use of food packaging derived from fossil resources has led to severe environmental issues, including excessive waste, pollution, and resource depletion. This urgent problem underscores the need for sustainable packaging alternatives that can mitigate these negative effects. In this presentation, the cutting-edge field of active food biopackaging is explored, which incorporates natural extracts from different crops and by-products to enhance the safety and quality of packaged food. The incorporation of these natural elements into biopolymers offers a promising solution to the growing demand for eco-friendly packaging. We will address the scientific foundations of this innovative packaging approach, focusing on the beneficial biological activities of natural extracts. Furthermore, we will address the critical issue of potential contamination of these extracts, such as mycotoxins and pesticide residues. A key part of the presentation will be the examination of various natural extracts, including those from rosemary (*Rosmarinus officinalis* L.), green tea (*Camellia sinensis* L.), and citrus by-products. These extracts are known for their ability to inhibit lipid oxidation and reduce microbial contamination, which can significantly extend the shelf life and preserve the freshness of packaged foods. We will also assess the effectiveness of active food biopackaging across different food models and discuss the challenges that may arise during commercialization. Additionally, we will identify the factors that most significantly influence the performance of active food biopackaging. This presentation aims to broaden the understanding of sustainable active food packaging incorporating plant extracts, providing valuable insights to guide industry practices and foster the development of environmentally friendly packaging solutions.

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PRODUCTION POTENTIAL OF THREE HIGH-VALUE MEDICINAL HERBS, TURMERIC, BASIL, AND MOUNTAIN MINT IN NORTH ALABAMA

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Herbal products, with an estimated global market of $10.7 billion in 2023, continue to gain popularity as health supplements. The need for high-yielding varieties and production technology are major factors limiting their commercial production. The objective of this research was to address these limitations through variety selection and developing production practices for three selected high-value medicinal herbs, turmeric (*Curcuma* spp.), basil (*Ocimum* spp.), and Virginia mountain mint (*Pycnanthemum virginianum*) in North Alabama, USA. Turmeric is gaining popularity in the US as a health supplement to combat inflammatory diseases. Basil possesses a myriad of medicinal properties and is known as a panacea for many ailments ranging from common colds to chronic diseases such as cancers and diabetes. Mountain mint is used in the medicinal and confectionery industries and could serve as an alternative to peppermint. Several turmeric, basil, and mountain mint varieties were evaluated for their growth and yield using replicated field trials and organic production methods. In Phase 1 trials, the fresh rhizome yields of twelve turmeric varieties ranged from 9 to 27 MT/ha, with curcumin levels ranging from 0 to 3.2%. The average fresh rhizome yield and curcumin content were 17 Mt/ha and 1.23%, respectively. In Phase II trials, the yield of 11 Vietnamese genotypes selected for high curcumin levels ranged from 5.5 to 14.7 MT/ha. The total curcumin content varied from 0.9 to 8.7%, averaging 5.2% across 11 genotypes. The high curcumin-containing Vietnamese varieties produce lower rhizome yields than low curcumin-containing varieties. The dry above-ground biomass (AGB) and leaf yield of twenty-six **basil** varieties belonging to 7 species ranged from 141.5 to 365.8 g/Plant and 20.0 and 80.8 g/Plant, respectively. The average AGB and leaf biomass were 226.6 and 46.0 g/Plant, respectively. The *O. gratissimum* accessions generally produced taller and larger plants with higher AGB and leaf biomass than other accessions. Two of the four mountain mint varieties grown in North Alabama showed consistently high yield potential. The mean seasonal total fresh AGB was 900.5 g/plant in Year 1 and 1308 g/plant in Year 2. The varieties M1 and M3 were superior in performance compared to other varieties. The studies demonstrated the potential of three medicinal herbs adapted to the North Alabama environment. The three medicinal herbs merit further evaluation for developing them as viable commercial medicinal crops in Alabama and perhaps the southeastern USA.

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ABSTRACTS

FIBERS AND CELLULOSIC CROPS DIVISION

ORAL PRESENTATIONS

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THE POTENTIAL OF MULTIFUNCTIONAL NATURAL FIBERS: FROM MACRO TO NANO SCALE

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Fibers are the basic building block of many materials and despite the fact that, for years, these structures have been mainly applied in textiles manufacturing, they have strong potential for several applications including the medical field, automotive area, aerospace industry and civil engineering. Natural fibers, such as flax, sisal, jute, hemp, among others, are collected directly from nature and are considered eco-friendly materials. Compared with synthetic fibers, they present numerous advantages, including high abundance, low-cost, biodegradability, biocompatibility, low-weight, and good mechanical properties. One of the most recent strategies for the natural fibers surface treatment is the incorporation of nanoparticles. Several types of metal and metal oxide nanoparticles can be used (silver-Ag, zinc oxide-ZnO, calcium oxide-CaO, silica-SiO_2, titanium dioxide, magnesium oxide-MgO, graphene nanoplatelets, etc.) to introduce different functions such as antimicrobial activity, antistatic capability, self-cleaning, UV protection, flame retardancy, thermoregulation, electrical conductivity and piezoresistive to natural fibers. The fibers' functionalization with these materials (doped and co-doped), allow the development of new fibrous systems with applications in several areas. In the military sector those can be used for: monitoring vital biological signs of soldiers, chemical/biological protection and self-decontaminating systems. They can also be used in sports, as well as in therapeutic applications (wound healing, wound dressing and drug delivery systems). Regarding biomedical applications, the last trend technology for new fibers production is electrospinning, cellulosic nanofibers (Nfbs) synthesized by electrospinning have been investigated extensively for biomedical applications because they exhibit similar microstructure to extracellular matrix, and they are able to mimic the biological microenvironment. Polymeric Nfbs also present high surface area, high porosity with interconnectivity which promotes cell adhesion, proliferation, drug delivery, and mass transport properties.

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APPLICATION OF CELLULOSE NANOCRYSTALS TO IMPROVE THERMAL ENERGY STORAGE IN SALT HYDRATE SYSTEMS

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As the demand for energy increases globally, there is a concerted effort to replace expensive and hazardous materials with renewable systems. In response, the energy sector has faced challenges in reducing costs and extending the lifetime of sustainable energy storage devices. Salt hydrates have demonstrated thermal energy storage abilities through thermochemical means by reversible bonding of water molecules. Materials have exhibited energy density between 400-870 kWh/m^3 with low operating temperature (<150˚C) and are generally low cost but are prone to degradation over use. Previous efforts to improve stability have primarily attempted salt impregnation within some porous [rigid] host matrix. However, the expansion of salts during hydration has led to the degradation of the host matrix and salt leakage. Cellulose nanocrystals (CNCs) derived from plant materials have shown promise in their ability to strengthen structural frameworks of composites in numerous applications. CNCs have generated significant interest due to their superior mechanical strength, high aspect ratio, high surface area, liquid crystalline nature, and hydrophilicity to support interaction between salt and water. Various salts such as $CaCl_2$, $MgSO_4$, $SrCl_2$, $ZnSO_4$, and Na_2S and their blends were employed in the study. The research goal was to develop and optimize promising salt:CNC composite materials for effective heat output and potential dehumidification over extended cycling periods while maintaining thermal reliability. Salts and CNCs were combined to produce composites of varying mass ratios (60:40; 80:20; 90:10). Salt:CNC systems were evaluated using transmission electron microscopy to confirm successful nucleation. Material performance was evaluated using simultaneous thermal analysis. The addition of CNC to salts significantly enhanced material performance in $SrCl_2$:CNC, $SrCl_2$:$CaCl_2$:CNC, $MgSO_4$:$SrCl_2$, and $CaCl_2$:CNC formulations. $SrCl_2$ containing formulations in particular were found to possess high energy storage capabilities exceeding 600 J/g and demonstrate thermal reliability of ≥90% over 50 cycles by addition of CNC.

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THE DECOMPOSITION OF FIBER HEMP RESIDUES IN THE SOIL

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Soil is one of the vital elements ensuring ecosystem sustainability, serving as a fundamental component for agricultural systems and acting as provider of ecosystem services. Improper tillage, unbalanced crop rotation and improper use of chemicals can irreversibly affect the soil and induce unfavorable processes such as soil erosion, compaction or loss of fertility. One of the ways to preserve healthy soil could be to look for ecological alternative solutions for agriculture and soil cultivation. Fiber hemp (*Cannabis sativa* L.) is widely cultivated for its seeds and inflorescences, which are widely used in the food and cosmetic industries, but one of the main problems is the utilization of residues which are left after harvesting of seeds or other parts. It is known that hemp stems are rich in lignin and cellulose and contain fiber which is heavily biodegradable. Since there are not many studies on the mineralization of residues and their impact on soil, the purpose of this study is to evaluate the rate of decomposition of hemp residues and the impact on soil quality. This experiment was conducted using three treatments: 1. hemp residues were mixed into the soil in autumn 2. hemp residues were mixed into the soil in early spring 3. hemp residues were left on top of the soil. Field experiment results presented that after 30 days, the highest mineralization process was identified in the treatment where hemp residues were left on the top of the soil, while the lowest mineralization rate was in the treatment where fiber hemp residues were mixed into the soil in autumn. However, after 330 days, the results revealed that the highest mineralization rate was determined in the treatment where hemp residues were mixed in the soil in autumn, and the lowest mineralization rate was identified where hemp residues were left on top of the soil. This tendency could be related to weather conditions and also could be explained by microorganism activity. In the treatment where residues were left on top of the soil, microorganisms actively degraded simple organic components, but a longer time period was needed to break down the long chain components. Meanwhile, in the treatments where residues were mixed in the soil, the population of microorganisms was higher and the degradation process took less time because of more favorable environmental conditions, e.g., temperature and moisture conditions are more stable compared with the top of the soil.

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UTILIZATION OF COFFEE GROUND WASTE AS FURNITURE MATERIAL

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Coffee (*Coffea arabica* L.) is considered as one of the biggest plantation crops that is cultivated in a large area for agricultural or industrial importance. Coffee takes an important place in tradition, culture, and social life around the world. It is known that more than 2.5 billion cups of coffee are consumed daily, all over the world. Each year, the coffee industry generates over 10 million tons of coffee waste worldwide. The study is inspired by the zero-waste mindset and turning coffee waste into value-added usable products. In this sense, a direct usage of ground coffee waste has been tried as well as partial replacement with wood material to produce particle boards. Coffee waste materials were obtained with Arabica from the local coffee shop at İstanbul, Turkey. The coffee waste was collected and dried at 70°C for 24 h in a hot-air oven. After drying, the moisture content of the coffee waste was about 5%. Experimental sets were prepared at 25%, 50%, 75%, and 100% coffee waste ratio in substitution to wood particles. Based on oven dry particle weight, 4% polymeric methylene diphenyl diisocyanate (pMDI) resin was applied. Hand formed mats were pressed in a hot press. Panels with dimensions of 500 x 500 x 8 mm were made for the experiments. The target density was 700 ± 50 kg/m³, additionally samples were prepared at higher density such as 1000±50 kg/m³ for comparison. Test samples were prepared and tested according to EN standards. The samples are conditioned at 60±5% relative humidity and at a temperature of 23 ± 2°C prior to tests. The prototypes were tested physically and mechanically according to European Norms EN 312 (2010). Internal bonding strength of %100 coffee boards was higher than the hybrid prototypes however bending strength values are debated for this particular rate. These results show that wood particle involvement in certain amounts is crucial when there is need for load bearing properties. Overall, the study establishes that ground coffee wastes can be used as raw material in replacement with wood particles to produce furniture parts.

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INVESTIGATION OF CROP RESIDUES FOR ACOUSTIC PANEL PRODUCTION

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The current global challenges related to carbon dioxide emissions and climate change pull attention towards the green building concept. Because it is known that 50% of the emissions released to the atmosphere comes from the building materials. Green buildings require the use of renewable natural resources, which reduce carbon emissions and consume less energy for the operation of buildings. Buildings as living quarters and workplaces also noise is a major problem for society and the demand for acoustic solutions which are cost-effective, renewable, eco-friendly in nature is increasing. In addition to this, population growth and industrialization in the world have caused increased consumption demands, excessive resource use and environmental problems. Studies on alternative resources and reuse of waste have increased due to the promotion of sustainable development and circular economy. This situation has also affected the forest products industry. It has become important to investigate alternative lignocellulosic sources to wood raw materials. The aim of this study is to protect forest resources and investigate the potential of using agricultural waste in the panel industry instead of fossil-based materials. In this study, agricultural resources and waste amounts commonly grown in Turkey were examined. Corn (*Zea mays* L.) stalk, corn cob, and hemp (*Cannabis sativa* L.) hurds were selected to produce lightweight composite boards to be used as acoustic wall panels. In this sense, a direct usage of crop residues has been tried instead of wood with particleboard production processes. Crop residues were dimensioned to a certain particle size. Experimental sets were prepared at 100% corn stalk, 100% corn cob, 100% hemp hurd, and %100 wood. Urea formaldehyde was selected as a binder. The specific gravity is targeted as 400±50 kg/m^3. Laboratory scale panel prototypes were prepared with 16 x 500 x 500 mm laboratory scale hot press to determine the performance characteristics. The acoustic properties were tested individually; the procedure described in the ISO 10534-2 standard was followed to determine the sound absorption coefficient with the impedance tube - transfer function method. In terms of ecological approaches, the use of biobased materials is important as well. For further investigations additional experimental sets are made using tannin-based resins made of lignocellulosic residues. The prototypes were tested physically and mechanically according to European Norms EN 312 (2010). As a result of the tests, it was seen that crop residues had potential to be used as a substitute for wood. The most positive results in terms of acoustic tests were obtained from corn cobs.

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INDUSTRIAL HEMP CULTIVAR GRAIN YIELD PERFORMANCE IN NORTH DAKOTA

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Introducing a crop into a new growing region requires screening existing varieties for trait expression to enable regional producers, in selecting high yielding varieties, that produce greater profits. A replicated field study conducted at the Prosper off-station research site located approximately 24 km NW of Fargo, ND, is associated with the North Dakota Agricultural Experiment Station and North Dakota State University, Fargo, ND. The study conducted in the 2023 growing season was a randomized complete block design with four replicates. Fourteen industrial hemp (*Cannabis sativa* L.) varieties sourced internationally were evaluated for trait expression for stand establishment, flowering, plant height, plant and stem lodging, seed moisture at harvest, harvest date, and grain yield. Standard agronomic best management practices were applied for crop production to enable sustainable crop performance. Variety differences were noted for all evaluated traits except plant and stem lodging where all varieties produced low values for both traits which would seem surprising since variety plant heights ranged from 1.75 to 2.77 m but illustrates the high fiber strength of industrial hemp. Days from planting to flowering ranged from 25 to 35 days for 11 varieties with three varieties flowering 42 days after planting. The economic value for industrial hemp is primarily based on grain yield although there is an emerging fiber market developing. Grain yield among the 14 hemp cultivars ranged from 931 to 3134 kg/ha with mean yield across cultivars at 1597 kg/ha. The economic grain value among the 14 hemp cultivars ranged from $931/ha to $3134/ha with the mean yield across cultivars valued at $1038/ha. Insight regarding potential variety grain yield performance could have a great effect on grain yield value and producer profits and sustainability. Variety yield expectations should be based on several years' performance at a location since weather and other factors are variable from season-to-season resulting in variety ranking yield differences among seasons.

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MOISTURE CHARACTERISTICS OF BIODEGRADABLE COMPOSITE HYDROMULCHES FOR SUSTAINABLE ORGANIC HORTICULTURE

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Mulching is vital in horticultural production for weed suppression, soil nutrient enhancement, and moisture conservation. Widely used low-density polyethylene (LDPE) mulch, despite its effectiveness, poses environmental challenges due to poor recyclability, contamination and its long-term presence in the ecosystem. Biodegradable hydromulches (HM), composed primarily of cellulosic materials and tackifiers, offer a sustainable alternative. This study evaluated various HM formulations to identify those with optimal moisture resistance properties and mechanical strength. Various formulations were tested comprising paper, wood fiber, and hemp (*Cannabis sativa* L.) hurds, mixed with tackifiers, such as guar (*Cyamopsis tetragonoloba* L.) gum, psyllium (*Plantago ovata* L.) husk, and camelina (*Camelina sativa* (L.) Crantz) meal. The experiments were focused on puncture resistance under varying moisture levels and rain fastness. Results showed that HM formulations' puncture resistance decreased significantly with increased moisture, dropping below 0.50 MPa at 50% moisture content, regardless of tackifier type. Rain fastness tests indicated that paper-based HMs retained integrity better than wood-based ones, with paper formulations losing only 4-37% of their original strength compared with wood formulations. Material loss during simulated rainfall was minimal, with paper-based HMs showing a rain fastness index (RFI) of 0.93, superior to wood formulations' RFI of 0.84. Overall, paper-based HM formulations demonstrated superior performance, with the top five formulations containing paper and varying concentrations of guar gum, psyllium husk, and camelina meal. These findings suggest that paper-based HMs are promising biodegradable alternatives to LDPE mulch, suitable for organic farming.

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COMPARATIVE YIELD STUDIES BETWEEN HEMP AND KENAF IN GREECE

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A large number of industrial crops could be grouped as fiber crops namely bast fiber crops (hemp (*Cannabis sativa* L.), flax (*Linum usitatissimum* L.), kenaf (*Hibiscus cannabinus* L.), grasses (*Miscanthus* spp., switchgrass (*Panicum virgatum* L.), *Spartina* spp.), woody species (poplar (*Populus* spp.), etc. The majority of bast fiber crops (e.g., flax, hemp, kenaf) are multipurpose crops and provide feedstock to feed biorefineries. The aim of this research work was to compare two bast fiber crops (hemp and kenaf) in an arid area in central Greece (Viotia). The field trials were carried out for three subsequent growing years (2021, 2022 and 2023. Both crops were compared under three nitrogen rates (0, 30 and 60 kg N/ha), and three irrigation rates (25, 50 & 100% of PET). The under-study varieties were for hemp Future 75 and Futura 83 and for kenaf CH-3 and CH-95. At the end of each growing period a final harvest took place (4 m^2 per plot) to estimate the biomass yields. At the same time a certain plants per plot were taken and weighted and then separated to stems, leaves and seeds. The stems had been further separated to bark and core. Sub-samples from all part fractions had been oven-dried to determine the moisture content. Great differences had been recorded between the stem yields of the two bast fiber crops with the yields of kenaf to be double of those recorded for hemp (>20 t/ha for kenaf and up to 10 t/ha for hemp). It was found that irrigation gave higher differences among the measured yields. Thus, when kenaf fully irrigated gave 16% higher stem yields compared to the plots received 25% of PET. The effect of irrigation on yields was more profound for hemp compared to kenaf and thus the fully irrigated crops of hemp were 40% higher yields compared to the plots that received the low irrigation rate. In terms of nitrogen effect, it was found that the hemp yields were 21% higher when received 60 kg N/ha (compared to the control plots) and the corresponding increase for kenaf was 16%. To sum up, the comparative studies carried out for three subsequent years for two bast fiber crops showed that kenaf was the most productive with more than double yields compared to hemp when grown in the same area and with the same treatments.

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FROM FARM TO PACKAGING: INCORPORATING *CYNARA CARDUNCULUS* L. LEAF EXTRACT IN WHEY PROTEIN-BASED BIOPOLYMERS

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A significant number of agro-industrial by-products rich in bioactive compounds are generated and wasted daily. It is necessary to develop strategies for reusing these by-products, thus ensuring a circular economy and, consequently, the planet' sustainability. *Cynara cardunculus* L. (cardoon) is a crop that thrives in challenging environments, while maintaining high productivity. Cardoon has several applications, being used in Mediterranean cuisine, cheese production as a vegetable rennet, biomass production, among others. Its leaves, the main generated by-products, are rich in bioactive compounds with antioxidant and antimicrobial activities. This study aims to develop a whey protein based active film, incorporated with ethanolic cardoon leaf extract in different concentrations (0.5%, 1.0%, and 2.0%). Overall and specific migration analyses will be performed to evaluate the release of phenolic compounds from active films into food. Ethanol 95% (v/v) will be used as the food simulant substitute, where the films will be submerged and kept at 40 ºC for 10 days. The DPPH free radical scavenging and the β-carotene bleaching assays will be performed to assess the antioxidant capacity. In addition, the total phenolic content and the total flavonoid content will be determined. The identification and quantification of the individual phenolic compounds present in the simulant will be performed by UHPLC-DAD. A gradual migration of phenolic compounds from the film to the food is expected to extend foods' shelf life. This strategy aims to make the most of agro-industrial by-products, which are normally discarded, by reusing them to extend food's shelf life, thus preventing waste and promoting the circular economy of this crop.

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ABSTRACTS

NATURAL RUBBER AND RESIN DIVISION

ORAL PRESENTATIONS

CHAIR

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DEFICIT IRRIGATION ON GUAYULE (*Parthenium argentatum* A. GRAY) GROWTH AND RUBBER PRODUCTION

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Understanding guayule's (*Parthenium argentatum* A. Gray) response to deficit irrigation is critical for irrigation management under water shortage to maximize rubber and resin accumulation throughout the growing seasons. A study was conducted on clay soil at Eloy, Arizona to compare plant growth and rubber accumulation among different irrigation treatments for four years (April 2020 to March 2024). Six irrigation treatments were included: 1) Full irrigation: Irrigate with 75% ETo (evapotranspiration rate) as determined by the model developed in a previous project; 2) Stress before harvest: Full irrigation for the first 16 months, then stop irrigation; 3) Minimum Year2: Year 1 irrigate as determined by the model, and Year 2 irrigate three times (March, April/May, and September); 4) Half Irrigation: Irrigate every other irrigation as determined by the model; 5) Minimum irrigation: Irrigate three times a year (March, April/May, and September); 6) One_irrigation: one irrigation after establishment in the first year, one irrigation in year 2. Two guayule genotypes, AZ-2 and AZ-6, were included in each plot. After 2 years of growth, 75% of the 80-m long plots were harvested and allowed to regenerate. In March, 2024, the 4-year-old crop and the 2-year-old regenerated crop were harvested. Aboveground biomass, rubber and resin content, and rubber and resin yield were measured in March 2022 and March 2024. Guayule plants in the treatment 5 and 6 survived summer in 2020 (the second hottest and driest summer after 2024) without irrigation from July to September. However, some plants in the One_irrigation treatment died in summer 2024 (the hottest and driest in Arizona history). Biomass and rubber/resin yield were linearly correlated with irrigation amount. The regrowth crop had lower productivity due to lower irrigation amount, indicating that a certain amount of irrigation is required for increased guayule productivity. Biomass and rubber and resin yield from 2-year-old first crop plus the 2-year regenerated crop were significantly higher than that of the 4-year-old crop, indicating harvesting and regenerating guayule is a better strategy. However, the difference was much smaller in the water-stressed treatments. This study indicates that guayule plants could survive severe drought in Arizona summer with minimum irrigation. While rubber and resin and biomass yield were positively correlated with irrigation amount, deficit irrigation under water shortage situations could still produce significant yield.

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POLLINATION TESTS ON GUAYULE (*Parthenium argentatum* A. GRAY) WITH TWO SPECIES OF DIPTERA: *Sphaerophoria rueppellii* AND *Lucilia sericata*

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In recent years, a guayule (*Parthenium argentatum* A. Gray) crop has been established in Castilla-La Mancha, Central Spain (Santa Cruz de la Zarza), where its interaction with various native pollinators has been observed. Guayule presents difficulties in seed fertility, and the participation of pollinators in the process can be essential to increase the production of seeds and their viability. The aim of this study was to test if the presence of specific pollinators had a direct effect on the biomass and seed production. Two species of pollinators were chosen: *Sphaerophoria rueppellii* (Wiedemann, 1820) (Fam. Syrphidae) and *Lucilia sericata* (Meigen, 1826) (Fam. Calliphoridae), due to the wide presence of these species in the guayule fields. Twelve greenhouses (4 x 2 x 2m) protected with anti-trips mesh were planted with 120 guayule plants of AZ-5 accession each. Four types of pollination, with three replicates each, were assessed: *S. rueppellii, L. sericata*, non-pollination and open pollination. The populations of *S. rueppellii* and *L. sericata* were released according to the supplier's specifications on 23 June 2023 considering the plot surface, and renewed during a month (every two weeks for *S. rueppellii* and weekly in the case of *L. sericata*). At the end of the study, all plants were harvested, and dry weight was determined: 3.7 ± 0.3 kg in the case of open pollination, 4.70 ± 0.4 kg for *L. sericata*, 5.6 ± 0.3 kg for *S. rueppellii*, and 5.6 ± 1.1 kg in the case of no pollination. Significant differences between open pollination and *S. rueppellii* and non-pollination were found, with an intermediate value for *L. sericata* that was not different from free pollination or the other two treatments. Regarding seed production, seeds were collected, cleaned and weighed. MANOVA analysis showed that both harvesting date and pollination, as well as their interaction, were significant. It was observed that seed production decreased significantly with time, and in terms of total seed production, open pollination produced significantly less clean seed than the other pollinations, while non-pollination produced more seed than *L. sericata*, and the production by *S. rueppellii* was intermediate between non-pollination and *L. sericata*. Pollination seems to influence biomass and seed production. Therefore, more studies on how the presence of pollinators affects guayule should be carried out. Currently, germination tests are being carried out to determine the influence of pollinators into the germination rate depending on treatment.

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GROWTH CHARACTERISTICS OF HISTORICALLY SIGNIFICANT MANZANAR GUAYULE (*Parthenium argentatum* A. GRAY) PLANTS UNDER GREENHOUSE CONDITIONS

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Cultivation and breeding of guayule (*Parthenium argentatum* A. Gray) took place in the Owens Valley of California, USA from 1942-1945. Japanese-American scientists and horticulturalists developed guayule agronomic practices and rubber extraction technologies, and, importantly, advanced improved germplasm, while held in the internment camp known as Manzanar under U.S. Executive Order 1066. A few publications documented successful results, but most of the records were lost once the internment camp was closed. Nevertheless, internee Glenn Kageyama, a plant specialist, retained Manzanar line germplasm and grew plants in Lomita, California from ~1965-2015. Seeds from these plants were collected and donated to the USDA National Plant Germplasm System in 2015. Their distinct appearance and historical significance motivated a study to document phenotypic characteristics. Plants from Manzanar germplasm, seven CAL accessions and two AZ accessions were grown under greenhouse conditions in Albany, California for one year. Phenotype data were collected for six plants per accession including biomass, plant size, branching, inflorescence #, and stem and bark thickness. Leaf and flower traits were detailed. Rubber and resin content were determined for selected plants. The Manzanar plants showed the lowest biomass, and smallest stem thickness, among the accessions studied. Rubber content was intermediate but, interestingly, resin content lowest, compared to the other lines. By design, the accessions included guayule diploid, tetraploid, and hybrid plants, which were readily differentiated by several descriptors, especially leaf morphology. Leaf area, width, and perimeter, especially, differentiated diploid lines, as expected. Other plant descriptors, particularly those related to flower morphology, were remarkably similar across dissimilar genotypes. One exception was the Manzanar line with a lower disc flower count compared to most other lines in this study. A comparison of greenhouse phenotypes to field phenotypes will be presented where the datasets permit. While the greenhouse characteristics are not expected to predict field performance, in some cases relative comparisons were found to hold surprisingly well for key indicators such as biomass and % rubber. This information may aid researchers seeking to differentiate developmental lines in greenhouse studies.

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CLIMATE SMART GUAYULE (*Parthenium argentatum* A. GRAY)

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Natural rubber production from a desert shrub, guayule (*Parthenium argentatum* A. Gray), has the potential to produce carbon-negative rubber by contributing to multiple ecosystem services under improved climate-smart agricultural practices. Guayule offers the opportunity to create a new natural rubber industry that mitigates the risks of hevea *(Hevea brasiliensis* L.*)*; creates a secure, supplemental supply of natural rubber; has impactful, sustainability benefits; and improves rural wealth in underserved arid farming communities. This shrub, native to Mexico and the Big Bend area of Texas, provides a model for optimizing desert cropping systems in terms of climate impacts while concurrently addressing water issues due to reduced requirements compared to traditional crops. Without considering carbon sequestration or direct field emissions, guayule rubber is already competitive (1.03 kg CO_2-eq. per kg rubber) with traditional hevea rubber production (1.21 kg CO_2-eq. per kg rubber) based on life cycle greenhouse gas (GHG) accounting. The CO_2-eq. per kg rubber includes the emissions due to transport from Asia to the US. Additionally, a guayule-based natural rubber industry includes biofuels from bagasse, high value products from resin (adhesives, bio-insecticides), and other bio-based co-products, further de-risking the economics while concurrently improving environmental impacts by displacing petroleum-based products. Funding was obtained through the Partnerships for Climate Smart Commodities, USDA program to create a domestic natural rubber-based bioeconomy that is constructed with best management practices to reduce GHG emissions leading to carbon-negative rubber production; adoption of climate-smart agricultural practices by underserved (rural and tribal) stakeholders, enabling the sustainability of farming in the Southwest while bringing high-skill, high-wage post-processing jobs to the region; and develop data-based models and experimental validation of the carbon cycling and savings with results integrated into the Cooperative Program for Operational Meteorology, Education and Training (COMET) to support expansion of guayule production beyond the industrial and farming partners in this project. An overview of the project will be presented outlining the measurement, monitoring, reporting and verification (MMRV) plans to quantify GHG emissions and sinks; as well as the implementation of climate-smart practices in partnership with regional growers.

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GUAYULE (*Parthenium argentatum* A. GRAY) BUSINESS DEVELOPMENT

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Guayule (*Parthenium argentatum* A. Gray) is one of the hevea (*Hevea brasiliensis* L.) natural rubber (NR) alternatives to produce hypoallergenic latex and technically specified rubber (TSR) rubber but also coproducts (resins, bagasse, and others). Guayule NR production and latex & rubber extraction have been widely studied and numerous publications and patents deal with it. This new natural latex, good for the planet and the people, and GuaTecs company, have been validated by i-Lab and Solar Impulse Foundation awards. The current challenge facing guayule NR commodity is to reach an industrial scale. This paper will discuss the strengths, weaknesses, opportunities, and threats (SWOT) of this route; the main steps we are facing during the scale-up process (regulation aspects, agronomical and industrial challenges, and customer relationships); the marketing position of the guayule latex (optimization versus applications); the profitability and sustainability; the European Common Agricultural Policy (CAP) subsidies; and the financing strategy for such bio-economy and industrial startup challenges. We will show that a global strategy must be developed with European (for the European CAP subsidies, especially) and Intercontinental (for the American Society for Testing Materials (ASTM) standard aspects, especially) collaborations.

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SHOOT REGENERATION CAPABILITY AND PARTIAL SELF-INCOMPATIBILITY OF A *Taraxacum kok-saghyz* GERMPLASM

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The perennial rubber dandelion, *Taraxacum kok-saghyz* (Tk) (also known as Russian or Kazakh dandelion), is a rubber-producing plant native to the Tien Shan mountain valleys in Kazakhstan. Rubber dandelion is currently being developed as an alternative commercial source of natural rubber in North America, Asia, and Europe where cultivation of the tropical tree *Hevea brasiliensis*, the conventional source of natural rubber, is not suitable. Rubber dandelion produces rubber mainly in the roots. Due to its self-incompatibility (SI) in seed production, Rubber dandelion exhibits high variability in important traits such as root morphology and rubber content. Germplasm utilization and biotechnology are potential approaches to developing commercially viable Tk crops. We conducted a survey of a Tk germplasm, W6-35169, to assess individuals for their overall plant morphology, in vitro plantlet regeneration capacity and self-incompatibility. Plants exhibited different leaf and root morphology. Characterization of 83 calli derived from 23 seedlings revealed callus induction capacity ranged from 42–79%. Majority of the calli developed unviable shoots such as leafy-like structures or albino shoots. Few calli produced significant numbers of viable shoots ranging from 26–187 per callus. We hand-pollinated 31 plants and found two individuals capable of producing selfed seeds. We identified plant #12 that was competent in producing shoots and selfed seeds. This individual is particularly useful in implementing a genetic approach for basic and applied research to improve a Tk crop.

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PRELIMINARY EVALUATION ON RUSSIAN DANDELION (*Taraxacum kok-saghyz*) GERMPLASMS FROM XINJIANG, CHINA AND EFFICIENT GENETIC TRANSFORMATION OF A HIGH-RUBBER GERMPLASM

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Russian dandelion (*Taraxacum kok-saghyz*, TK) is one of the most promising alternative natural rubber (NR) crops, and also the model plant for studying NR biosynthesis. More than 200 wild germplasms were collected in Zhaosu County, Xinjiang, China. Of these germplasms, 113 successfully propagated by tissue-culture were potted in soil and grown for six months in a greenhouse before phenotyping. The root dry biomass per plant and root rubber content of these germplasms ranged from 0.3 to 4.6 g, and 3.3% to 30.3%, respectively. Among the 35 germplasms with above 15% rubber content, one germplasm named TK20, stood out for its high root biomass. With the optimized hormone combination of 1 $mg \cdot L^{-1}$ kinetin (KT) and 0.4 $mg \cdot L^{-1}$ indole-3-acetic acid (IAA), an average of 15.2 normally regenerated shoots per leaf disc explant could be achieved for TK20. Base on this high-efficiency shoot regeneration technique, TK20 was successfully transformed via *A. tumefacien*-mediated leaf disc transformation, with the transformation rates of 40.1% and 41.2%, respectively, for the two pCAMBIA vectors carrying the *RUBY* or the *β-glucuronidase (GUS)-green fluorescent protein (GFP)* fusion reporter. The TK germplasms reported here and the system of high-efficiency vegetative propagation and genetic transformation developed will benefit for both basic and applied research in this self-incompatible, heterogenous yet highly valuable grass species.

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GENETIC DISSECTION AND IDENTIFICATION OF CANDIDATE GENES FOR GIRTH AND RUBBER YIELD IN *Hevea brasiliensis*

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Rubber tree (*Hevea brasiliensis* Muell. Arg.) is a vital tropical economic tree that provides the sole commercial source of natural rubber (NR), an important industrial raw material. The cultivation of elite latex-timber clones that exhibit both enhanced NR and wood production has become a key objective in current *H. brasiliensis* L. breeding programs. However, the genetic basis of girth and rubber yield traits is still limited. Quantitative trait loci (QTL) mapping and genome-wide association study (GWAS) analysis are effective strategies for identifying the loci controlling these traits. We conducted resequencing-based genotyping and multi-year phenotype investigations in a Whickham germplasm offspring population. Seventeen and 76 single nucleotide polymorphisms (SNPs) were identified by GWAS, respectively, correlated significantly with girth and dry rubber yield (DRY), and corresponded to 31 and 284 candidate genes for girth and DRY. Gene expression analyses were further performed to screen potential candidate genes. Finally, a cullin protein and an iridoid oxidase protein were identified as prospective girth regulators, whereas two chloroplast thylakoid membrane proteins and an auxin-repressed protein were implicated in shaping the performance of rubber yield. Additionally, an F1 population was developed from a cross between CATAS8-79 and GT1, and the traits of girth and rubber yield were also investigated. Resequencing-based QTL mapping identified 8 environmentally stable QTLs for girth and 16 for rubber yield. Notably, two QTLs for girth, *QGirth-4* and *QGirth-7.2*, were consistently detected. Further analysis revealed that a candidate gene, *HbGID1*, regulates the development of girth. These findings contribute to a deeper understanding of the genetic foundations of girth and rubber yield, as well as molecular-assisted breeding of high-yielding rubber clones.

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SESQUITERPENES AS BIOMARKERS FOR GUAYULE (*Parthenium argentatum* A. GRAY) GENOTYPES CLASSIFICATION

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Guayule (*Parthenium argentatum* A. Gray) has emerged as a potential sustainable source of natural rubber. Rubber biosynthesis depends on complex interactions between several metabolic pathways that nowadays are under study in guayule. The search for metabolites related to these pathways could be helpful to predict guayule phenotypes and to analyze metabolic interactions. To this end, we performed a meta-analysis of several metabolites with 5-years data from 27 accessions in field conditions obtained from various published studies. The data analysis included rubber, resin, guayulins and volatile sesquiterpenes from essential oils, trying to relate its content to the genotype of each accession. Results showed that rubber and resin were not able to separate accessions by genotype, indicating that they are influenced by the environment. On the other hand, both the guayulin (non-volatile sesquiterpenes) individually and together with volatile sesquiterpenes from essential oil content can classify the accessions into three main groups: pure guayule, mariola (*Parthenium incanum* Kunth) and non-mariola hybrids, and unknown hybrids. These groups correspond with previously reported genotype classification suggesting that guayulins are mainly regulated by genetic factors rather than by the environment. These results suggest that guayulins and volatile sesquiterpenes could be used as biomarkers, providing new information for the development of breeding programs. Furthermore, it could be interesting to analyze if these compounds are also related to rubber biosynthesis and how they interact in order to obtain improved lines with enhanced natural rubber production.

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FRACTIONATING GUAYULE (*Parthenium argentatum* A. GRAY) ESSENTIAL OIL: VOLATILE CHARACTERIZATION AND ANTIOXIDANT ACTIVITY

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From the ~3000 known essential oils (EOs), only about 300 are used commercially, even though there is a growing demand from major end-user industries by their known antifungal, antibacterial, anti-inflammatory, and antiviral properties. Such activities are related to EO composition, complex mixtures with more than 300 different organic volatile compounds, generally of low molecular weight below 300 Da. In guayule (*Parthenium argentatum* A. Gray) EOs, up to 50 different compounds have been identified, maintaining in general its compound profile regardless of the accession studied, with yields above 0.5% that make it potentially interesting to be exploited for this purpose. The purpose of this study was to obtain different volatile fractions from guayule EO, and determine their volatile profile, phenolic content, and antioxidant activity. The three EOs fractions were obtained by controlling temperature and pressure between ranges of 100-180ºC and 0.02-0.15 bar in a short-path vacuum distillation apparatus (B-585 Kugelrohr) from guayule essential oil. Volatile characterization was carried out by gas chromatography-mass spectroscopy (GC-MS) QTOF, the total phenolic content (TPC) of the fractions was determined using Folin-Ciocalteu reagent, and the antioxidant activity by the α, α-diphenyl-β-picrylhydrazyl (DPPH) free radical scavenging method. The three fractions of guayule EOs differ considerably in their volatile composition in comparison with the original one. While the EO2 fraction had a total monoterpenes content of 97%, the EO3 fraction was enriched in the sesquiterpenes family (76%). The latest fraction, EO4, contains only sesquiterpene volatile compounds. The fractions with the highest TPC content were EO3 and EO4, with values of 0.78 and 0.50 mg GAE/g extract, respectively. Observing the DPPH activity among the different fractions, also EO3 and EO4 exhibit the highest IC50, corresponding to the fractions with the highest amount of sesquiterpenes. Further studies will be developed with EO3 and EO4 guayule oil fractions to establish their potential exploitation as preservatives in the food industry or antioxidants in the cosmetics sector.

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COMBINATION OF ARGENTATIN A AND 5-FU EXERTS A SYNERGISTIC EFFECT AND INDUCE LATE APOPTOSIS ON THE COLORECTAL CANCER CELL LINE RKO

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Colorectal cancer is the third most diagnosed cancer in the world and the second leading cause of cancer related death in both men and women. Conventionally, treatment has been based on the administration of 5-fluorouracil (5-FU), but both recurrence and failure to respond to treatment over a prolonged period generate the need for new therapeutic options. Two compounds isolated from guayule (*Parthenium argentatum* A. Gray), argentatin A and B, have already shown some activity against some cancer cells. In this regard, the cytotoxicity of these compounds was evaluated in several colon cancer cell lines, both in monotherapy and in combination with 5-FU. The combined treatment revealed a synergistic effect, enhancing the effect on cell viability, and reducing the need for high doses, even by reducing their IC_{50} to 50%, potentially minimizing the side effects associated with conventional chemotherapy. Our results support that argentatin A is able to induce a quiescence stage when there is a significant cell cycle arrest in G0/G1 phase. Besides, both argentatins (A and B) individually reduce cell viability independently of apoptosis, while in combination they induce late apoptosis, the effect of which is greater than using 5-FU in monotherapy in the RKO cell line. These findings encourage the exploration of the capacity of argentatins and their semi-synthetic derivatives as a new strategy to improve the efficacy of 5-FU based antitumor therapies.

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ARGENTATINS SENSITIZE NON-SMALL LUNG CANCER CELLS (NCL-H1299) RESISTANT TO CISPLATIN TREATMENT

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Cancer is one of the diseases that continues to represent one of the greatest challenges for contemporary medicine. Specifically, lung cancer is the number one in incidence and mortality with a rate of almost 2.5 million and 2.0 million, respectively. Histopathologically, is classified into two subtypes, small cell lung carcinoma (SCLC) and non-small cell lung carcinoma (NSCLC), of which NSCLC represents the majority of lung malignancies, reaching 80% of cases, with a survival rate of 15%. Cisplatin (CDDP) is the first line chemotherapeutic for lung cancer, however it has important limitations, such as chemoresistance and tumor recurrence. In this context, the exploration of therapies based on natural products, such as plant extracts, is emerging as a growing trend, as it offers the possibility of tackling current limitations in cancer treatment. One example is guayule (*Parthenium argentatum* A. Gray), a shrub that can produce resin as a by-product, whose most abundant secondary metabolites are argentatins, triterpenes that have shown antitumor properties in several cellular models. Thus, with this premise, we evaluated the cytotoxicity of argentatins A and B in a panel of lung cancer cells and compared it with the effect of the chemotherapeutic of choice. We selected the most sensitive cell line and exposed it to a single and continuous dose of CDDP and argentatins for three months. The line exposed to CDDP generated resistance to treatment, increasing its IC_{50} about 8-fold, while those treated with argentatins did not. Likewise, the cisplatin resistant cell line was sensitized when treated with a combination of argentatin A and argentatin B at very low concentrations. On the other hand, the most resistant line was selected for combined therapy and synergy trials with argentatins and CDDP, in which only half of the IC_{50} of CDDP and argentatin B reduced cell viability by 54%, demonstrating an additive effect with the combination of different concentrations of both compounds.

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GENERAL CROPS AND PRODUCTS DIVISION

ORAL PRESENTATIONS

CHAIR

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INVESTIGATING MARGINAL SOILS FOR IMPROVED AND SUSTAINABLE CROP PRODUCTION IN A UNIQUE RESEARCH FIELD INFRASTRUCTURE

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In the context of a sustainable, bio-based economy, the production and sufficient provision of biomass for material and/or energy applications is a critical bottleneck. To avoid land use conflicts with food production in biomass generation, it is essential to utilize previously unused and/or agriculturally non-viable, nutrient-poor marginal soils and to enhance and make them suitable for plant production. This goal is pursued, among other things, by the scientific endeavors at the unique "Marginal Field Lab (MFL)". This includes the development and execution of field experiments that i) evaluate the transferability and further development of results obtained from laboratory and greenhouse trials in a "lab to field" approach, and ii) demonstrate the usability of the experimental field and the plantings for further research approaches, including food and feed production. This newly established and artificially created research field is located in central-west Germany, on the spoil heap of the Hambach opencast mine in the Rhenish mining area. In collaboration with the energy company RWE, a sandy substrate from the opencast mine was deposited on an area of more than 4 hectares. This substrate contains neither organic carbon (C_{org}) nor other plant-relevant nutrients. It is characterized by a very high sand and gravel content and low water holding capacity. Targeted fertilization strategies, such as subsurface fertilization with digestate, humic acids, and algae biomass compared to mineral NPK fertilizer, are tested for the cultivation of economically relevant and alternative (biomass) plants. These include perennial plants such as *Miscanthus x giganteus*, *Sida hermaphrodita*, *Silphium perfoliatum*, the biennial plant *Mellilotus officinalis*, and the annual plants *Carthamus tinctorius,* and *Hordeum vulgare*. Additionally, the trial cultivation of *Cannabis sativa* and *Crotalaria juncea* is planned. By installing suction cups at several locations in defined soil depths and regularly taking soil samples, the possible leaching of applied nutrients and the plant-induced C_{org} enrichment in the soil are investigated. The overarching goal is to make statements about the suitability of various plants for cultivation on opencast mine terraces and residual areas, to subject these unused fallow lands to economically meaningful interim use. In addition to carbon sequestration by the plants, erosion of these areas is prevented, and ecosystem services are implemented. The obtained biomasses are intended to be used as raw materials for bio-based industries, such as fiber/paper and oil/chemical companies, in the context of regional structural change.

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CULTIVATION OF ENERGY CROPS ON POLLUTED LANDS FOR BIOENERGY PRODUCTION

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Soil pollution has become a global environmental problem, leading to the degradation of soil quality, a reduction in ecosystem services, and a negative impact on biodiversity. Nonetheless, this land could serve as an alternative for cultivating non-food lignocellulosic crops to produce bioenergy. The GOLD project is funded by the EU and aims to cultivate selected high-yield lignocellulosic energy crops on polluted land for dual objectives: generating feedstock for biofuels with minimal risks of indirect land use change (ILUC), and aiding in land remediation by applying optimized phytoremediation solutions. Two-year field cultivations of *Sorghum bicolor* (var. Bulldozer) and *Miscanthus x giganteus* were carried out on five sites, located in 4 countries (Greece/two sites, Poland, France and Italy). The application of biostimulants (mycorrhiza, fulvic/humic acids, and protein hydrolysates) were also tested. The type and level of soil pollution per site and the crop growth, productivity and phytoremediation potential were determined. The main pollutants in all four countries were metal(loid)s, with Cd, Pb, Zn, Ni, and Cu being the most abundant. The experiments were a split-split plot design with three replicates. Plant growth parameters, yields and shoot metal removals were determined. In the most multi metal polluted site of Lavrion-GR, all crops displayed reduced growth, resulting in lowest productivity and the highest shoot metal concentrations. The biomass yields (t DW ha^{-1}) from highest to lowest were in sorghum: 23.1 (Kozani-GR) > 21.0 (PL) > 18.4 (IT) > 14.2 (FR) > 10.8 (Lavrio-GR), and in Miscanthus, 14.0 (IT) > 6.1 (PL) > 6.0 (Kozani-GR) > 5.1 (Lavrio-GR). The phytoremediation potential was assessed in terms of shoot metal uptake, thus, the potential removal of the soil metals in g ha^{-1} and per year. The highest uptake per hectare were in sorghum: 126 g Cd (FR), 411 g Pb (Lavrio-GR), 4440 g Zn (PL), 230 g Ni (Kozani-GR), and 101 g Cu (IT) and in Miscanthus: 7 g Cd (Lavrio-GR), 97 g Pb (Lavrio-GR), 749 g Pb (Lavrio-GR), 190 g Ni (Kozani-GR), and 57 g Cu (IT).In conclusion, both crops could be cultivated on the polluted sites, showing an ability to tolerate increased metal concentrations in the soil. However, sorghum was the most effective crop in all cases, providing higher yields and a greater potential to remove metals from the soil compared to miscanthus.

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EVALUATION OF INNOVATIVE CROPPING SYSTEM IN MARGINAL HILL AREA IN NORTH ITALY

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In recent years, the concept of marginal lands has gained significant scientific and policy interest, particularly due to the increasing demand for biomass for non-food purposes. In Europe, a considerable portion of land is already classified as marginal, and this is likely to expand due to climate change. The MIDAS project aims to evaluate the suitability of a number of resilient industrial crops on marginal land. Among these, safflower (*Carthamus tinctorius* L.), hemp (*Cannabis sativa* L.), crambe (*Crambe abyssinica* L.) and miscanthus (*Miscanthus x giganteus*) have been evaluated in North Italy at the experimental farm of the University of Bologna (Ozzano dell'Emilia). The site is characterized by poor chemical composition (sand >65%), and a medium slope (10-15% varying across the site). In order to differentiate feedstock production and to promote biodiversity, a strip intercropping system was set up, including alternate wide strips (4-12 m) alternating annual and perennial crops. The project is currently in its second year of trial. In the first growing season (2023), the three annual crops achieved satisfactory production levels, reporting for safflower and crambe a seed yield of 1.7 and 2 Mg DM/ha, respectively, while for industrial hemp the total harvested biomass was 12 Mg DM/ha. To sum up, the production levels of individual annual crops were on average with previous results under non-limiting conditions. The perennial grass, miscanthus, has not been harvested yet, since it is still at the establishment phase, which is a problematic part of its management, and the past year precipitation that occurred in May had a negative effect on its vigor. In this growing season (2024), all annual crops were sown between late January and late March. The density (plants/m^2) achieved by the crops is comparable to the density levels achieved under non-marginal conditions. Specifically, hemp density is 120 plants/m^2, crambe density is 120 plants/m^2, and safflower density is 30 plants/m^2. Regarding miscanthus, a second rhizome transplant was performed in April to address failures from the previous year. The establishment was not optimal due to a concentration of rainfall towards only the end of the month. However, the late-month rains are expected to have helped. Activities are ongoing, and the next productive results will be available at the end of the cultivation cycle. In conclusion, the HE-MIDAS project represents a significant effort to assess the potential of resilient industrial crops on marginal lands, offering promising prospects for soil restoration, biodiversity enhancement and addressing challenges related to climate change while creating new economic opportunities for farmers.

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PRODUCING LIGNOCELLULOSIC FEEDSTOCK BY CULTIVATED SELECTED LIGNOCELLULOSIC CROPS ON LIGNITE MINING AREAS FOR ADVANCED BIOFUELS PRODUCTION

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In the view of the GOLD EU research project (www.gold-h2020.eu) field trials had been established in several contaminated sites in Europe and Asia. The aim of this project is to produce lignocellulosic feedstock for advanced biofuels production by growing selected lignocellulosic crops on contaminated sites and contributing in their remediation. One of the field sites located in north-east of Greece (Kozani) in the premises of a lignite mining plant that was mainly contaminated by Ni. The energy crops were two perennial grasses (*Miscanthus* spp. and switchgrass) (*Panicum virgatum* L.) and one annual herbaceous crop (biomass sorghum (*Sorghum bicolor* (L.) Moench). The field trials were established in May-June 2022 (by seeds for switchgrass and sorghum and by rhizomes for miscanthus) and two biostimulants combinations were applied in all crops; protein hydrolysates x mycorrhiza and fulvic/humic acid x mycorrhiza, while control was included. All crops had a good establishment and the yields estimated annually by a final harvest that was carried out at the end of each growing period. The yields of the two perennial grasses (miscanthus and switchgrass) at the end of the second growing period were quadrupled in the case of miscanthus (28.8 vs 6.1 t/ha) and doubled in the case of switchgrass (14.5 vs 7.0 t/ha) compared with the establishment year. The highest dry matter yields for both perennial grasses (miscanthus and switchgrass) were in the plots with protein hydrolysates x mycorrhiza and were 33.5 t/ha for miscanthus and 16.9 t/ha for switchgrass. Similar findings had been recorded for sorghum in both years with dry matter yields of 26.6 t/ha in 2022 and 34.6 t/ha in 2023. It should be pointed out that although sorghum is an annual crop, great differences had been recorded between the two growing seasons in terms of dry matter yields that were 24.3 t/ha in 2022 and 33.8 t/ha in 2023, averaged overall treatments. At the end of each growing period biomass samples had been analysed for their Ni concentration. Among the three cultivated crops the highest Ni concentration was in switchgrass samples and more specifically for the plots with protein hydrolysates x mycorrhiza applied. Averaged overall treatments, the highest Ni concentration was measured for switchgrass (6.1 mg/kg, mean of two years, whole plant) followed by miscanthus 5.5 mg/kg, while the lowest one was measured for sorghum 4.6 mg/kg.

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OPPORTUNITIES AND CONSTRAINTS ASSOCIATED WITH THE PRODUCTION OF ENERGY CROPS IN CONTAMINATED SOILS – IDENTIFICATION OF PATHWAYS TO A GREEN ECONOMY

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Dedicated crops represent an important feedstock to decarbonise the energy sector and to meet the no net emissions of greenhouse gases by 2050, as set by the European Green Deal. However, the greenhouse gas performance of biomass to energy can be negatively impacted by indirect land use change (ILUC) effects. Consequently, cultivation of industrial crops on contaminated land is suggested as an approach to minimize land use competition with food crops and land use change controversies. The GOLD project (Bridging the gap between phytoremediation solutions on Growing energy crOps on contaminated LanDs and clean biofuel production) aims to produce clean low ILUC biofuels by growing selected high yielding lignocellulosic crops on contaminated land, and, in long-term, to return the polluted lands back to the agricultural production. The first task of the project aims to select high-yielding lignocellulosic energy crops (*Miscanthus* spp., switchgrass (*Panicum virgatum* L.), biomass sorghum (*Sorghum bicolor* (L.) Moench), and industrial hemp (*Cannabis sativa* L.)) for phytoremediation purposes. The objective of this work was to identify opportunities and constraints associated with the cultivation of these lignocellulosic crops in contaminated soils. In the study, crop management options were assessed, namely the use of plant-associated microorganisms and a variety of biostimulants, to optimize the phytoremediation action, amount of fertilizers and pesticides applied, irrigation needs, level of intensity of machinery used, among others. Effects of the cultivation of those crops in the contaminated soils were addressed towards yields, impact on soil and on the biodiversity and landscape. Results obtained suggest that growing these lignocellulosic crops in contaminated soils provide benefits regarding soil properties and erodibility, although yields are affected by the level of contamination. Miscanthus and industrial hemp showed benefits related with the biological and landscape diversity, due to the higher density of the biomass that provides higher coverage to wildlife. Use of water resources, fertilizers and machinery caused a higher constraint in the annual crops, industrial hemp and sorghum, than in the perennials, due to the amount and level of intensity needed. Yet, all the crops studied showed a limited need in pesticides. The use of appropriate management practices (plant-associated microorganisms and a variety of bio-stimulants) penalizes the biological diversity index, but rewards the impact on the soil quality index, by greater reduction of soil contaminants.

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PROMOTING THE SUSTAINABLE CULTIVATION OF *CISTUS LADANIFER* L. FOR BIOECONOMIC GROWTH IN DEMOGRAPHICALLY CHALLENGED AREAS

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Rural areas, often dependent on traditional sectors like agriculture and livestock farming, face complex issues including lack of economic diversification, population decline, and environmental degradation. The circular bioeconomy plays a crucial role in promoting economic diversification in these regions by fostering the development of value-added supply chains. This approach supports the emergence of new economic activities based on renewable and sustainable resources. By creating local jobs and reducing the dependency on those traditional sectors, the economic resilience in rural communities can be enhanced. In this framework, the sustainable cultivation of *Cistus ladanifer* L., known as gum rockrose, serves as a strategic element for boosting economic resilience in areas with declining populations in the Central Iberian Peninsula. Often linked to challenges such as agroecosystem invasion, interspecies competition, and the potential for forest fire propagation, *C. ladanifer* offers substantial opportunities for sustainable development by opening new market niches. Additionally, the sustainable utilization of gum rockrose promises numerous ecological benefits, aiding in the restoration of ecological integrity and improving climate change adaptability. Forest management practices associated with gum rockrose harvesting provide opportunities to restore multifunctionality to degraded landscapes. This includes activities like extensive livestock farming, transhumance, beekeeping, ecotourism, and recreational use of gum rockrose areas. These integrated activities can drive green employment opportunities and support the repopulation of these regions.

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PRODUCTION AND CASCADING USE OF PERENNIAL INDUSTRIAL CROPS BIOMASS

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Perennial industrial crops (PIC) are an important group of plants that are a source of lignocellulosic biomass. There are three groups of crops among the PIC: (1) fast-growing shrubs and trees; (2) herbaceous crops, and (3) grasses. Until now, the main directions of PIC biomass utilization were energy purposes and transport of biofuels. On the other hand, in line with the bioeconomy concept, opportunities for cascading use of biomass should be sought, including the production of various renewable food and non-food bioproducts as well as energy, environmental and social services. The cascade method of using PIC gives greater benefits, because in the first place, substances of higher value are obtained from lignocellulosic biomass, which can be used in the chemical, cosmetic, pharmaceutical, feed and even food industries, and only post-production residues or post-extraction biomass are used for energy goals. It is emphasized that the cultivation and use of PIC brings economic, social and environmental benefits, especially when plantations are located on marginal land, which are of little or no use for growing food or fodder plants. Thanks to this approach, it is possible to at least partially reduce the competition between food crops and energy and industrial crops. Although PIC plantations are recommended to be established on marginal land, efforts should be made to obtain high yields of biomass, which results in the effectiveness of this type of production. The research conducted by our team has been looking for the possibility of PIC production and the cascading and sustainable use of biomass. In the first place, lignocellulosic biomass should be used for high-value bioproducts, e.g. in the pharmaceutical, cosmetic, chemical, and even food and feed industries, and then the post-extraction biomass can be a substrate for further applications, including, for example, energy. The conducted research showed and confirmed that it is possible to produce PIC in the conditions of north-eastern Poland and the quality of the obtained lignocellulosic biomass enables its cascade use in the direction of obtaining extracts, including bioactive substances, and the use of residues for energy purposes and in some cases for insects rearing. It was also found that from the point of view of energy, economic and environmental efficiency, the production and use of lignocellulosic PIC biomass is fully justified and brings measurable benefits.

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INTERCROPPING WITH PULSE CROPS INCREASES MICRONUTRIENT ACQUISITION AND CONTROLS RUST DISEASE ON MAIZE

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Global food security is threatened by plant disease, and crop diversification often promotes productivity through reduced disease and facilitation for increased nutrient acquisition. However, whether such facilitation is a factor in disease resistance is unknown. The aims of the study were to determine how crop diversity affects crop productivity and rust disease on maize (*Zea mays* L.), and whether competition or facilitation between pulse crop species and maize correspond with resistance. Five irrigated intercropping experiments with different fertilization and crop combinations were conducted at two sites for four years. Productivity (542 data points) and disease severity (27150 data points) of maize monoculture, maize intercropped with pulse crops and maize intercropped with non-pulse crop were compared. A meta-analysis of literature was performed to confirm the broader applicability of results from these field experiments. Pulse-based intercropping increased the aboveground biomass of intercropped maize by 8% and grain yields by 10% in comparison to non-pulse-based intercropping. Disease severity on maize intercropped with pulse crops was reduced by 45% and 48%, compared to monocultures of maize and maize intercropped with non-pulse crops, respectively. Moreover, as interactions among intercrops became more facilitative, the concentrations of zinc (Zn), copper (Cu) and iron (Fe) in maize increased, and these increases were highly correlated with decreasing disease severity. The global meta-analysis showed consistent results with our field experiments, as lower disease severity was associated with greater intensity of interspecific facilitation or with lower intensity of interspecific competition. Lower disease severity was closely related to enhanced acquisition of nutrients that can enhance the resistance to crop diseases, driven by stronger interspecific facilitative effects in intercropping systems. Facilitative effects on maize was increased by the identity of pulse companion crop species, and was increased by sufficient irrigation, but reduced by applications of nitrogen and phosphorus fertilizers. Our findings identify a novel facilitative mechanism in general and advance the understanding of the facilitative mechanisms that underlie disease control through crop diversification.

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DEVELOPMENT OF LAB-SCALE GUAYULE BAGASSE PYROLYZER

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A lab-scale pyrolyzer has been built at the University of Arizona to produce and characterize biochar produced from guayule (*Parthenium argentatum* L.) bagasse. As guayule is a perennial shrub with an 18 month to 2-year harvest cycle, handling and disposal of the residual bagasse will be a cyclic operation. Pyrolyzing the bagasse into bio-char is a carbon sequestration method that can further enhance the environmental benefits of guayule in addition to reducing water footprint and the production of domestic natural rubber. The current research is aimed at and optimizing char production while minimizing formation of organic liquid byproducts. The pyrolyzer is currently undergoing an initial shakedown test program. Activities include performing leak testing and time-to-purge experiments. Results of these tests will be presented along with preliminary biochar formation rates as a function of pyrolysis temperature and pressure profiles for both pine chips and guayule bagasse materials. Pyrolyzer emissions are monitored using Forensic's FD series gas detectors (www.forensicsdetectors.com). These are electrochemical cell-based systems. One is configured to monitor CO_2 to 100%, oxygen to 30%. The second is configured to monitor non-condensable flammable gases typically produced by hydrolysis including H_2 (to 40,000 ppm), methane to 100% of LEL, CO to 10,000 ppm as well as CO_2 to 100%. The CO_2, O_2 detector will be utilized during initial apparatus purging prior to the start of an experiment to verify oxygen level is below 1%. Preliminary purge testing has been completed. The pressure vent-process takes three fill-vent cycles to reduce oxygen concentrations to below 1%. In this process, the reactor is pressurized to 20 psig then vented, then the process repeated. An alternate, 'slow purge' process was also evaluated with an initial optimal flow-time scenario of 400 ml/min nitrogen for slightly over 6 minutes to attain similar residual oxygen levels. This testing will continue to optimize time and minimize purge gas requirements prior to starting a pyrolysis experiment.

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DIGITAL TOOLS IN THE BIOECONOMY

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Bioeconomy involves the use of renewable raw materials for production of goods and services for everyday use. A wide range of industrial crops provides a broad selection of biomass for bio-industry development. According to the report 'Polish countryside and agriculture 2023' conducted by the Ministry of Agriculture and Rural Development, rural residents increasingly believe that the situation of Polish agriculture is deteriorating, especially when it comes to the low profitability of agricultural production, which depends on several factors: difficult growing conditions, increasingly frequent droughts, or expensive mineral fertilisers. Bioeconomy is needed to gradually replace fossil fuel-based production, and to function in line with the concept of circular economy. The analyses of stakeholders' needs, innovative ideas and interests regarding bio-solutions for rural areas conducted in the framework of the BioRural project show that the biggest barriers for their adoption indicated by Polish farmers are the lack of financial resources, clear guidelines or a national bioeconomy strategy, as well as insufficient knowledge. The same survey identified long term economic benefits, growing consumer demand or financial incentives as the driving factors for the implementation of bio-solutions by practitioners. The latest digital tools developed to promote the uptake of bio-solutions in rural areas can improve their economic situation. One of such instruments is the digital toolkit recently developed by the MainstreamBIO project, which creates opportunities, support, and advice tailored for biomass producers, business representatives and technology owners fitting into the concept of circular bioeconomy. The platform supports partnerships aimed at overcoming barriers and bringing bio-innovations to market with practical innovation support, accelerating the development of the already available bio-based products and services. In parallel, a digital toolkit is being created to align biotechnology, social innovation, and good practices in nutrient recycling of available biomass and market trends, as well as to expand knowledge of the bioeconomy through an educational package of resources based on existing research results and tools. The digital toolkit showcases a wide range of small-scale biotechnologies, innovative business models and social solutions. It also includes a set of practices aimed at recycling nutrients and organic matter back into the soil. The toolkit can be found under the link https://mainstreambio-digital-toolkit.eu.

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HOW GIS TOOLS CAN HELP TO IDENTIFY MARGINAL SOILS FOR THE BIOENERGY SECTOR IN MAINLAND PORTUGAL

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Bioenergy is a renewable and alternative energy, which is produced from the conversion of organic material, namely, biomass (including energy crops and wastes) through biological, chemical, thermochemical, and biochemical processes. Energy crops are industrial species (perennial, woody and annual species, algae, among others) that can generate energy, biofuels and bioproducts. The soils that should be most adequate for the production of energy crops in mainland Portugal are marginal soils (e.g. salinity soils), degraded soils (lands eroded by natural factors such as climate change that cause a physical, chemical and biological change in its nature, generating soil desertification), and contaminated soils (polluted with toxic elements and polymetallic agents) avoiding Indirect Land Use Change (ILUC) burdens. This study aims to use and apply Geographic Information System (GIS) tools to spatially relate land use selection and optimal species allocation, to determine adequate marginal areas, inadequate for food/feed crops, for the implementation of selected energy crops in mainland Portugal. To search which areas could be identified as marginal it is necessary to identify criteria: excess soil moisture, dryness and low temperature, steep slope, poor chemical properties, unfavorable texture and stoniness, limited soil drainage, and shallow rooting depth. Different databases from official websites of World, European, and Portuguese Institutions and Projects were consulted to build a preliminary map that shows all the marginal soils available in mainland Portugal. After, it was excluded from this map, all the areas belonging to the Portuguese National Agricultural Reserve (RAN), protected areas, and specific areas identified in the Land Use and Land Cover Map (COS 2018). A final map was obtained that shows the available marginal land that can be used for the cultivation of energy crops. This final map shows that less than 10% of the continental Portuguese territory can be used to allocate industrial crops for bioenergy/biofuels.

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POSTER PRESENTATIONS

SEED TRAITS AND MAPPING OF ASSOCIATED QUANTITATIVE TRAIT LOCI IN CAMELINA RECOMBINANT INBRED LINES

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Camelina [*Camelina sativa* (L.) Crantz] consists of both spring and winter biotypes. Winter camelina intercropped with food commodities can intensify crop production without impacting food security, whereas spring biotypes are an option for increasing production on marginal and fallow land or through double cropping with early-maturity varieties. To develop more resilient camelina germplasm for intensified production, recombinant inbred lines (RILs: 254 individuals) from a bi-parental cross between a spring (CO46) x winter (Joelle) biotype of camelina were created. Based on hierarchical clustering of difference in days to flowering (DTF) between non-vernalized and vernalized plants, the RILs are represented by 67 spring (0 – 11.2 DTF), 124 intermediate (11.7 – 31.7 DTF), and 63 winter (>33 DTF) types. In this study, seed from RILs of two F7:F8 and one F8:F9 generation were phenotyped for total oil, crude protein and fatty acid profile using near infrared spectroscopy (NIRS). Consistent with previously published data, differences of total seed oil and fatty acids [linoleic (18:2), linolenic (18:3), and eicosenoic (20:1) acids] among spring and winter biotypes were observed, based on least square means (LSM, α=0.05). Further, 2,412 single nucleotide polymorphism (SNP) markers mapped to the 20 camelina chromosomes (Chr) from reference genome C046 were used to identify quantitative trait loci (QTL) associated with these RIL seed traits. Loci significantly associated with oil were identified on chromosomes 9, 13, 15, and 17 with the best logarithm of odds (LOD) score of 16.7 in Chr13 that explained 22% of phenotypic variation. For linolenic acid, QTL were identified on chromosomes 1, 9, 17, and 20 with the best LOD score of 9.5 on Chr1 that explained 13% of phenotypic variation. Two *FATTY ACID DESATURASE* (*FAD*) genes, involved in synthesis of 18:2 and 18:3 fatty acids, were identified within 100 kb of the QTL peak on Chr1 for linolenic acid. For linoleic and eicosenoic acids, QTL were identified on Chr 2, 9, 10, 13, 15, 20, and 10, 13, and 20, respectively. The best LOD of 9.94 on Chr 20 explained 13% of phenotypic variation for linoleic acid and the best LOD of 5.95 on Chr13 explained 8% of phenotypic variation for eicosenoic acid. Interestingly, the transcription factor *FLOWERING LOCUS C*, which has been reported to target FAD7 in Arabidopsis [*Arabidopsis thaliana*], maps within 100 kb of the QTL peaks with the best LOD score for total oil, and linoleic and eicosenoic acids. These results provide a starting point for developing testable hypotheses and resources for breeders to improve seed oil traits in camelina.

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LUBRICANT PROPERTIES OF *Orychophragmus violaceus* SEED OIL AND ITS ESTOLIDES

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Chinese violet cress (*Orychophragmus violaceus* L.) is an annual herb native to China and North Korea. It is hardy in USDA zones 7 through 10 and can be grown on marginal land. It was recently introduced in the U.S. in the state of Virginia. Chinese violet cress oil contains two unique dihydroxy fatty acids, nebraskanic, and wuhanic acid. The purpose of this study was to characterize the lubricant properties of Chinese violet cress oil and estolides derived from it. The oil was extracted from the seeds and the fatty acid composition and antioxidant contents were analyzed. The physical properties were measured, including cold flow properties, lubricity, and viscosity. The oxidative stability was assessed by TGA and pressurized DSC. The properties of Chinese violet cress oil were compared to those of the hydroxy fatty acid (HFA) containing oils from castor beans (*Ricinus communis* L.) and lesquerella (*Physaria fendleri* L.). Estolides were prepared from the oils and evaluated as base oil lubricants. Due to its dihydroxy fatty acids, Chinese violet cress derived estolides have a branching structure compared to the linear castor and lesquerella estolides. The properties of the resultant estolides were discussed. Chinese violet cress could be a potential feedstock for producing bio-based products from marginal land.

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CREATION OF PENNYCRESS (*Thlaspi arvense* L.) CALIBRATIONS FOR NEAR INFRARED SPECTROSCOPY ANALYSES

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Field pennycress, *Thlaspi arvense* L., is a new oil seed cover crop being commercialized as a source of biofuel in the U.S. Midwest Corn Belt. Off-season integration of pennycress into existing corn (*Zea mays* L.) and soybean (*Glycine max* (L.) Merr.) acres would extend the growing season on established croplands and avoid displacement of food crops or ecosystems while yielding up to an additional 2 billion gallons of oil annually. As breeding programs work to alter fatty acid constituents, glucosinolate levels, and total oil content in the seeds, near infrared spectroscopy (NIR) has been employed to provide a non-destructive rapid assay for screening several breeding traits. Since historical NIR data for pennycress has been unavailable, NIR calibrations have been primarily based upon the spectra of related Brassica family oilseeds such as canola (*Brassica napus* L.). Our research was focused on collecting spectra from 477 populations of pennycress grown in triplicate at Western Illinois University in Macomb, IL to create NIR calibrations for oil, moisture, sinigrin, and fatty acid constituents in pennycress seed. In addition to spectra, gas chromatography, time-delayed nuclear magnetic resonance, and wet chemistry glucosinolate sinigrin analyses were performed to correlate NIR spectra with seed oil and moisture traits. These calibrations will provide more accurate results for high throughput screening of breeding lines for unique traits.

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CAMELINA GERMPLASM IN THE UNITED STATES USDA GENEBANK AND NOTABLE ACCESSIONS

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The US National Plant Germplasm System (NPGS) maintains a publicly available collection of 117 *Camelina* samples representing seven of the species in the *Camelina* genus (Brassicaceae) at the Ames distribution location. An additional seven accessions, all cultivars developed in the United States, have active intellectual property right (IPR) status and are held out of distribution until the IPR expires (2027 – 2043). An example of an accession with recently expired IPR status, PI 683517 became available in 2023. This line, WA-HT1, was developed at Washington State University and has tolerance to residual levels of group 2 herbicides so that it can be safely planted after Clearfield crops. *Camelina microcarpa* is the likely wild hexaploid ancestor of the crop species *C. sativa* and should be a reservoir of diversity useful for crop improvement. The NPGS collection contains 46 *C. microcarpa* accessions about half with European or Eurasian origin and half recently collected in four western U.S. states by JRB. During a flow cytometry examination of the USDA *Camelina* collection, PI 650135, was noted by JRB as having a genome size consistent with diploidy. Additional work supported that this accession represented a new diploid species which was named *Camelina neglecta* J.Brock, Mandakovia, Lysak & Al-Shenhbaz. *C. neglecta* likely represents a diploid genome in the hexaploid *C. sativa* genome. The accession was originally identified as *C. macrocarpa* and collected from a cornfield in the Causse Mejean region in southern France. This discovery highlights the value of the NPGS *Camelina* collection. With the potential importance for breeding and as a lab model, we would like to expand the collection of *C. neglecta* in the NPGS.

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CAMELINA SEED AND OIL YIELD FROM SELECTED INTERCROPPING SYSTEMS IN POLAND

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Intercropping is the practice of growing two or more crops simultaneously and is a sustainable agricultural strategy aimed at enhancing crop diversity, improving resource use efficiency, and increasing overall productivity. SCOOP project is focused on innovative and diversified organic intercropping systems aimed at preserving ecosystem and agricultural land integrity, biodiversity, and food/feed security. Camelina (*Camelina sativa* L. Crantz) is a short-season, drought-tolerant, low-input oilseed, therefore, it is a perfect candidate for intercropping in organic farming with other low input, underutilized crops. The aim of this research was to test different intercropping systems with camelina and underutilized crops in Poland. The chosen companion crops were: flax (*Linum usitatissimum* L.), lentil (*Lens culinaris* Medik), and spelt (*Triticum spelta* L.). In the entire experiment, the highest seed yield was obtained in sole spelt cultivation, 4.06 Mg/ha. On the other hand, the yields of flax, camelina, and lentil were lower and amounted to 2.45; 1.47 and 0.40 Mg/ha. Intercropping of camelina with companion crops caused a substantial decrease in yields of companion crops, down to 77%. Analyzing the total seed yield from intercropping systems, it was found that the highest yield was obtained from camelina intercropping with spelt 2.89 Mg/ha. Camelina intercropping with flax yielded up to 1.87 and with lentil up to 1.27 Mg/ha.

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SUSTAINABLE PRODUCTION OF BIOFUELS – ENVIRONMENTAL AND ECONOMIC PROSPECTS OF CULTIVATING CRAMBE IN CONTAMINATED SOILS

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The production of industrial crops in soils contaminated with heavy metals contribute to reduce land use competition with food crops and land use change controversies. Oilseed crops represent a source of medium-chain fatty acids and medium-chain polymer building blocks that can be used to produce biofuels, plastics, surfactants, detergents, lubricants, plasticizers and other products. In this context, this work aims to assess the environmental and economic prospects derived from the production of crambe (*Crambe abyssinica* Hochst R.E. Fries) in heavy metals contaminated soils. *Crambe abyssinica* were sowed in different soils artificially contaminated with Zn: 450 mg/kg; Pb: 450 mg/kg; Cd: 4 mg/kg; or Ni: 110 mg/kg. This work was carried out in pots, under semi-controlled conditions, in Caparica, Lisbon, with the duration of two vegetative cycles (seeds sowing in November 2021 and 2022, harvested in May 2022 and 2023). Over the two growing cycles, yields of *Crambe abyssinica* were on average 160 g/m^2 and the crop presented a high tolerance index to the studied heavy metal contaminated soils (> 0.75). Yet, the oil content in the seed was slightly affected by the level of contamination in the soil. A small increment was observed in protein content and ash content, of the seeds, with a lower content in oil. Results obtained suggest that growing crambe in contaminated soils provide benefits regarding soil properties and erodibility. Crambe also showed benefits related with the biological and landscape diversity, due to flowering. Yet, biodiesel production costs increase by 10%, because oil production per land area is affected by the level of contamination (showing no differences among the type of heavy metal contamination). Although the economic budget can be reduced, the production of crambre in soils contaminated with heavy metals represents an opportunity to provide feedstock for the oleochemical industry, contributing to decarbonizing the economy.

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RESPONSE OF CARINATA TO CONTRASTING SOWING DATES

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The European Directive 2023/2413 (Renewable Energy Directive III) established to increase the share of renewable energy to 42.5% by 2030 in the Member States. Sustainable alternatives to fossil fuels, such as biofuels derived from crops, could be used to pursue this goal. Nevertheless, it is important to avoid the land-use change risk by growing energy crops on marginal land or to replace fallow periods between food crop cycles. *Brassica carinata* is a new easy-to-grow oilseed crop of the *Brassicaceae* family used to produce especially renewable jet fuel. There is still limited information on the suitability of new improved genotypes and hybrids to Mediterranean pedo-climates and the existing cropping systems. Therefore, this study aimed to identify the most suitable genotype for the pedo-climatic conditions of northern Italy and to identify the optimal sowing date. The study was carried out at the experimental farm of the University of Bologna located at Cadriano (44°32'58" N, 11° 24' 32" E) in 2023-2024. Two sowing dates (spring and autumn) were investigated on three different carinata genotypes: one cultivar (HYB087) from Nuseed (France) and two cultivars (E18-0030 and E18-0082) from Agriculture and Agri-Food of Canada (AAFC) breeding program (Canada). The experimental design was a randomized block design with four replicates. The seeding rate was 175 seeds m^{-2}. The spring trial was sown on 19 April and the autumn one on 20 November. Nitrogen was applied in the amount of 60 kg ha^{-1}, as urea in stem elongation. In the spring trial, insecticide treatment against flea beetle (*Altica oleracea*) was applied, while in the autumn one it was not needed. At the end of each growth cycle, carinata was manually mowed and then threshed mechanically. After the threshing on representative seed samples from each plot, the 1000-seed weight and the seed oil content (%) were determined. So far, only results from the spring sowing are available. The massive attack of flea beetles negatively affected seed yield. Results showed significant differences among tested genotypes. HYB087 (Nuseed) reached the highest seed yield with 1.2 Mg DM ha^{-1} and an oil seeds content of 30%. E18-0030 (AAFC) showed the highest 1000-seed weight with an average value of 4.4 g and a seed oil content of 26%. Finally, E18-0082 (AAFC) achieved the lowest oil content (19%). Carinata sown in autumn showed much better vegetative growth compared with spring-sown camelina, also in relation to lower pest pressure. Therefore, in the autumn growing cycle, fewer agronomic inputs (e.g., pesticides) were needed. After the harvest of the autumn trial (planned before the end of June 2024), the results of the varieties tested on the two dates of sowing will be compared. Early results demonstrated that carinata could be included in innovative farming systems and provide the production of domestic and low-iLUC feedstocks.

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CAMELINA AS WINTER INTERMEDIATE CROP PRECEDING SUMMER FOOD CROPS

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The bioeconomy in Europe generates an annual turnover of around 2 trillion euros with more than 17 million of employees. However, Europe imported over 15% of the biomass feedstocks to supply the bioeconomy sector. Sustainable solutions are needed to support both the bio-based and agricultural sectors. The H-EU project CARINA (Carinata and camelina boosting the sustainable diversification in agricultural production systems) identified two oilseed crops, camelina (*Camelina sativa* (L.) *Crantz*) and carinata (*Brassica carinata* L.), to include in innovative cropping systems (e.g., double cropping systems) as intermediate cash crops. Thus, the study aimed to examine camelina as a winter intermediate crop preceding typical summer food crops (i.e., sunflower (*Helianthus annuus* L.), sorghum (*Sorghum bicolor* (L.) Moench)). At this scope, to accelerate camelina drying up and harvest, a pelargonic acid-based bioherbicide, obtained from vegetable oils supplied by Novamont (CARINA's partner), was tested. The study was conducted at the experimental farm of the University of Bologna located at Cadriano (44° 33′ N, 11° 23′ E) over two growing seasons (2022-2024). Three camelina commercial varieties were compared in large duplicated strips of about 2000 m^2: Lenka, a winter type by Poznan University (Poland), CCE44, a winter type, and CCE117, a spring type by Camelina Company (Spain). Camelina was sown in autumn at a rate of 6 kg ha^{-1} on 0.17-m row-spacing. Before the sowing, 200 kg ha^{-1} of 18:46 NP fertilizer was applied. When camelina seeds approached moisture content of about 35%, the pelargonic acid-based bioherbicide was sprayed on half of the area of camelina strips. After applying 14.5 L ha^{-1} of formulation diluted on 200 L ha^{-1} of water, camelina was completely dried in only 6 h, and the manual harvest of representative areas was performed. The other half of the camelina strips was harvested when the camelina reached physiological maturity. During the growth cycle, phenological parameters were measured. Seed yield was higher for camelina sprayed with pelargonic acid because the treatment ensured a 7-d-earlier harvest compared with typical harvest date, thus avoiding a hailstorm which caused remarkable seed losses. Among the three genotypes, CCE117 reached the highest seed yield (0.9 Mg DM ha^{-1}). Concerning the performances of the food crops following camelina, sunflower appeared more suitable for double cropping system, being able to achieve a seed yield of 1.8 Mg DM ha^{-1} in this system compared with 1.6 Mg DM ha^{-1} in the "business as usual system" winter fallow-sunflower/sorghum. Meanwhile, sorghum growth seemed to be impaired by the double-cropping system mainly in relation to too long of a cycle. Early results demonstrated the plasticity of camelina as a winter intermediate crop, as well as the great potential of pelargonic acid in anticipating and leveling out camelina maturity.

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SALINITY TOLERANCE FOR SEED GERMINATION AND VIGOR IN SPRING AND WINTER CAMELINA

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Camelina (*Camelina sativa* (L.) Crantz) is an oilseed of interest as a feedstock for sustainable aviation fuels due to its low carbon intensity. However, it is proposed for production as an intermediate crop and on marginal lands to avoid direct and indirect land use change emissions. Camelina has been reported to have salinity tolerance and be able to establish in marginal lands but there is no knowledge on how the different biotypes (spring and winter) tolerate exposure to different salts and salt concentrations. The objective of this study was to determine germination and vigor of spring camelina (C046) and winter camelina (Joelle) seed under saline conditions. A total of 50 seeds and a subset of 15 seeds were germinated in Petri dishes saturated with solutions of NaCl, $CaCl_2$, and Na_2SO_4 at concentrations of 0, 0.04, 0.08, 0.12, and 0.16 mol/L, in an incubator set to a constant temperature of 20°C and light. Germinated seeds were counted daily for 7 days. The set of 50 seeds was used to calculate the germination rate, vigor index, germination velocity, corrected germination index, biomass, and dry weight. The subset of 15 seeds was used to measure hypocotyl length and radicle length using ImageJ, an image processing program. The experimental design was a randomized complete block with three replicates. The results revealed that the interaction between salt and variety differed significantly ($p<0.05$) for vigor index, corrected germination index, biomass, hypocotyl length, and radicle length. However, there was no significant effect on germination rate, germination velocity, or dry weight. The treatment by variety was significant for vigor index, corrected germination index, biomass weight, dry weight, and hypocotyl length, but radicle length, germination rate, and germination velocity were not significantly different. The winter biotype of camelina had significantly lower values than the spring biotype for all parameters measured except for dry weight and hypocotyl weight. The Na_2SO_4 salt reduced germination, vigor, and dry weight more than NaCl and $CaCl_2$ across both biotypes and concentrations. In addition, Na_2SO_4 almost completely inhibited radicle and hypocotyl growth at concentrations > 0.08 mol/L. This is of significance, because Na_2SO_4 is commonly present in sodic soils in the northern Great Plains. However, the ability of camelina to germinate and establish in saline and sodic soils does not necessarily mean it will be productive, especially in sodic soils in which sodium disrupts soil structure and reduces water infiltration, inhibiting root growth.

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NEW MEDICINAL PLANTS AND ACTIVE INGREDIENTS FROM SAXONY-ANHALT

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The recently started project, NA-WIR, aims to establish new medicinal plants in Saxony-Anhalt and the integration of new value chains in the field of plant-based primary products and bioactive substances. Drought-stress-resistant species, such as rosemary (*Rosmarinus officinalis* L., syn *Salvia rosmarinus* Spenn.), sage (*Salvia officinalis* L.), and Chinese Isodon (*Isodon rubescens* [Hemsley] H. Hara), will be tested for suitability and then established in cultivation. The resulting plant-based primary products, such as spices, tea, or essential oils, will be supplied to the market. Additionally, to enhance long-term value, diterpenoids are pivotal in developing new value chains. Compounds like carnosic acid and oridonin exhibit a variety of bioactive properties and can be isolated in high concentrations from the selected plant species. Through biotransformation, the obtained substances will be converted into higher-value active ingredients and tested for antibacterial and anticancer properties, with a focus on periodontitis and various cancer cell lines. In addition, the new value chains will undergo sustainability and market transfer analyses, and the socio-economic impacts of the developments induced by the project will be determined. Moreover, NA-WIR offers the possibility to predict the modeling of relevant ingredients for optimal yield using machine learning methods and practical spectroscopic analyses. Digital data collection and modern FAIR data management allow project partners and stakeholders access to information about these plants and the analyses of their ingredients. The approaches developed in NA-WIR can serve as a blueprint for establishing new value chains for newly established specialty crops in Saxony-Anhalt in the future.

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EVALUATION OF NOVEL HEMP SELECTIONS

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Cannabis sativa with high cannabinoid content holds significant importance due to its diverse therapeutic and industrial applications. High cannabinoid varieties, such as those rich in CBD (cannabidiol) and low in THC (tetrahydrocannabinol), are highly sought after for their medicinal properties, including pain relief, anti-inflammatory effects, and potential benefits for mental health conditions like anxiety and depression. The selection and development of new hemp varieties with optimized cannabinoid profiles are crucial for enhancing the efficacy and specificity of cannabis-based treatments. Additionally, these new selections can improve crop yields, pest resistance, and environmental adaptability, making hemp cultivation more sustainable and economically viable. This ongoing research and breeding effort contribute to the advancement of the cannabis industry, while also supporting broader agricultural and environmental goals. This study evaluated 82 phenotypically different hemp selections resulting from the crossing of two hemp genotypes: the first being cv. Marina (from Serbia, included in the European List of Approved Hemp Varieties) and the second was a cannabinoid-type hemp selection from the United States. The CBD content in the dry material ranged from 0.207% (DZ 17) to 14.740% (DZ 72), and the THC content ranged from 0.085% (DZ 17) to 0.447% (DZ 13) (Table). Additionally, 32 selections were chosen for evaluation of the essential oil (EO) content and composition. The major EO constituents were β-caryophyllene, α-humulene (α-caryophyllene), nerolidol, caryophyllenyl alcohol, and caryophyllene oxide. Additionally, CBD and traces of cannabichromene and dronabinol were detected in the essential oil. The results demonstrated that some promising new hemp varieties can be developed from these crossings.

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NEW MEDICINAL PLANTS AND ACTIVE INGREDIENTS FROM SAXONY-ANHALT THE POTENTIAL OF ROSEMARY AND SAGE

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Salvia rosmarinus and *Salvia officinalis*, commonly known as rosemary and sage, are aromatic shrubs originally native to Mediterranean regions but are now spread all over the world. Both plants belong to the family *Lamiaceae*, which is known for its fragrant and culinary uses, as well as its health-promoting properties. In traditional medicine, sage was used to treat diarrhea and gout, while rosemary was used for liver diseases, asthma and rheumatism. Nowadays, the main plant-based products derived from these plants are spices, tea, and essential oils. Additionally, rosemary extracts are utilized as antioxidants in food preservation and cosmetics. The most potent antioxidant compounds in these extracts are the abietane diterpenoids carnosic acid and carnosol. These compounds can be isolated in larger quantities from the selected plant species. Through biotransformation, these diterpenoids can be converted into higher-quality active ingredients and tested for their biological activities.

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DIETARY LIGNANS AS POTENTIAL NUTRACEUTICALS AGAINST NEURAL DAMAGE INDUCED BY HIGH FAT WESTERN DIET

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Dietary lignans are polyphenolic molecules found in fruits, certain vegetables and seeds that generally appear to have antioxidant and anti-inflammatory effects in the body. Excess consumption of saturated, or trans fatty acids, characteristic of a western diet, is associated with increased risk of chronic metabolic, cardiovascular and neurological diseases. In this study, we evaluated the effect of the dietary lignans matairesinol, pinoresinol and secoisolariciresinol on neural function in vitro. Palmitate and oleate in co-treatment with matairesinol, pinoresinol and secoisolariciresinol were investigated regarding their effect on neuron viability, oxidative stress, neuronal differentiation and membrane dynamics. It was found that palmitate or oleate were not neurotoxic at high or normal physiological concentrations when conjugated with albumin in various ratios. However, exposure of neural cells to these fatty acids led to increased reactive oxygen species production, with co-lignan exposure lessening this effect. Co-treatment of fatty acids with lignans also affected neuron differentiation and cell membrane lipid raft organisation as measured by immunofluorescence of synapses and cholera toxin assay, respectively. This work contributes to the specific medicinal and nutraceutical knowledge on the potential of dietary lignans with regards to responses in neural cells. These preliminary results provide important specific knowledge on how dietary adjustments or specific dietary lignan nutraceutical supplements may benefit neural health in disease and ageing.

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BIOLOGICAL ACTIVITIES AND PHYTOCHEMICAL COMPOSITION OF BALKANS ENDEMIC SPECIES *PINUS PEUCE* GRISEB. FROM BULGARIA

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Pinus peuce (Macedonian pine) is a Balkan endemic and tertiary relict distributed in the high mountains of Bulgaria, North Macedonia, Montenegro, Bosnia and Herzegovina, Albania, and northern Greece. Investigations into this endemic species are constrained by its limited distribution. However, their phytochemical composition has the potential for the discovery of new biomolecules and activities. This study investigated the phytochemical composition of *P. peuce* essential oils (EO), total polyphenol, and flavonoid content from different plant parts: leaves, twigs, wood, and cones. Furthermore, this study aimed to evaluate the biological activities of EO (biopesticidal and antimicrobial) and the radical scavenging activity of methanol extracts of different plant parts. Gas Chromatography-Mass Spectrometry (GC/MS) was utilized for analyses of the EO. The biopesticidal potential (insecticidal, repellent, and bioherbicidal activities) was evaluated in Petri dishes with three replicates. The total amount of phenols, flavonoids and antiradical activity was determined spectrophotometrically with a UV/Vis spectrophotometer. The EO yield varied among different plant parts and it was highest in the wood of one- to two-year-old twigs. The predominant compounds of the EOs (*α*-pinene, *β*-pinene, and limonene) of different plant parts were found in all analyzed trees from the five populations but in different amounts, depending on the plant parts. Camphenethe, *β*-myrcene, bornyl acetate, germacrene D and *β*-caryophyllene were found in large quantities in some plant parts. The female cones had the highest concentration of polyphenolic compounds, followed by the annual twigs and leaves, which is related to the higher antiradical activity of the extracts from these plant parts. The tested EOs of all plant parts of *P. peuce* had a higher antimicrobial effect against *Salmonella enterica* susp. *enterica* and *Escherichia coli.* The tested EO at six concentrations (5%, 4.5%, 3.5%, 2.5%, 1.5%, 1%) for insecticidal activity against *Sitobion avenae* and *Rhopalosiphum padi* had significant efficacy (100%), 24 h after the treatment. However, the EO demonstrated weak repellent activity against these pests. *Pinus peuce* EO from the twigs at concentrations 0 µL; 1 µL; 2 µL; 5µL; 10 µL, and 20 µL had significant bioherbicidal activity against weed seeds of *Anthemis arvensis* L. and *Papaver rhoeas* L. Furthermore, the sprout length and root length were reduced and inhibited.

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EFFECT OF SEMI-DESERT PLANTS EXTRACTS AS BIOSTIMULANTS IN ROOT AND AERIAL GROWTH OF *CAPSICUM ANNUM* L. AND *C. CHINENSIS* JACQ. SEEDLINGS

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In the search for sustainable agricultural alternatives, extracts from the semidesert plants emerge as a promising natural option to replace commercial biostimulants, as they do not rely on synthetic chemicals. These extracts, derived from plant species adapted to extreme climatic conditions, contain bioactive compounds that can promote seedling growth and development. Therefore, the aim of this study was to evaluate the effect of *Rhus muelleri* (RM), *R. virens* (RV), *Jatropha dioica* (JD), and *Juglans mollis* (JM) extracts as biostimulants to promote root and aerial growth of two chili varieties: Jalapeño (*Capsicum annuum* L., cv. Mitla), and habanero (*C. chinense* Jacq., cv. Orange). Evaluations were conducted both *in vitro* and under greenhouse conditions. Extracts from RM, RV, JD, and JM were tested at three different concentrations (75, 100, and 200 mg/L) along with commercial root biostimulants, Rootex (RT) and Raizal (RZ), and an absolute control (AC). The total length of the radicle and plumule, as well as the fresh weight of the seedlings, were measured. For the greenhouse stage, the extracts were evaluated first in trays and subsequently in pots, at two concentrations (75 and 200 mg/L), along with RT, RZ, and AC. In both stages, the diameters and lengths of the roots and stems, as well as the fresh and dry weights of the roots and stems, were recorded. The results indicated that RM at a concentration of 200 mg/L and JD at a concentration of 75 mg/L showed higher biostimulation, compared to commercial rooters, promoting both root and aerial growth of chili seedlings *in vitro*, in trays, and in pots. These findings suggest that semidesert plant extracts have high potential as natural biostimulants, offering a sustainable and effective alternative to commercial products in promoting root and seedling growth.

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EXTRACTION AND CHARACTERIZATION OF POLYSACCHARIDES FROM *OPUNTIA* SPECIES FOR APPLICATION AS COATING SOLUTIONS

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Polysaccharides extracted from various plant species have attracted significant attention for their potential applications in developing coating and film-forming solutions. The *Opuntia* species, commonly known as prickly pear cacti, are particularly promising due to their adaptability to arid and semi-arid regions, and their unique morphological and physicochemical properties. These cacti are rich in bioactive compounds, including polysaccharides, which can be utilized in various industrial applications. Thus, the aims of this study were to extract and characterize polysaccharides from *Opuntia rastera* (OR) and *Opuntia lindheimeri* (OL), for their use in coating solutions for food applications. Cladodes from OR and OL were collected from wild sites in the southeastern region of Coahuila State. The samples were disinfected, weighed, and measured. Subsequently, the cladodes were cut and dried, followed by grinding into a fine powder. Polysaccharides extraction was conducted using an agitation method. The yield, particle size, degree of esterification, and viscosity of the extracted polysaccharides were measured. The polysaccharides yield was 12.70% for OR and 12.90% for OL. The degree of esterification was determined to be 71.03% for OR and 81.47% for OL. Fourier-transform infrared (FTIR) spectra confirmed the presence of hydroxyl groups, indicating successful extraction of polysaccharides. Moreover, the particles of polysaccharides powder showed irregular shapes, and the size varied between 250 and 600 µm. This study successfully extracted polysaccharides from *O. rastera* and *O. lindheimeri*. Also, both species exhibited favorable physicochemical properties, indicating their suitability for developing sustainable biopolymer-based solutions for use in coatings with potential application in postharvest treatments and food packaging.

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OPTIMIZATION OF EXTRACTION OF *T. MASTICHINA*, *S. ROSMARINUS* AND *J. COMMUNIS* AND THEIR ANTIFUNGAL AND ANTIOXIDANT PROPERTIES TO THE FOOD INDUSTRY

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Medicinal and aromatic plants (MAPs) are known for their bioactive compounds, which have multiple benefits useful in the agri-food, cosmetics and pharmaceutical industries. BIOVALOR project "Sustainable Forest Management and Agriculture to obtain high-value bioproducts to face the demographic challenge" is financed by the Biodiversity Foundation and the Ministry for the Ecological Transition and the Demographic Challenge (MITECO). Among the different objectives of the project is the search for the potential of extracts from native aromatic-medicinal plants (MAP) adapted to marginal lands, for their inclusion as active raw materials in different stages of agri-food production and industry. The present study aimed to optimize the conditions for the Soxhlet extraction using the response surface methodology of three species of aromatic plants: *Salvia rosmarinus*, *Thymus mastichina,* and *Juniperus communis*. The effect of three independent variables was evaluated: solvent/sample ratio, solvent concentration and extraction time. The responses to be optimized were the final yield, the content of phenolic compounds and the antioxidant capacity on the DPPH free radical. The optimal conditions that maximized the three responses were 54 mL solvent/g sample, 61% ethanol and 3 h for *S. rosmarinus* , 51 mL solvent/g sample, 69% ethanol and 2.5 h for *T. mastichina* and 25 mL solvent/g sample, 91% ethanol and 1 h in the case of *J. communis*. Finally, the antifungal effect of extract concentrations ranging from 0,195 to 100 mg/mL was evaluated on different phytopathogenic fungi. *T. mastichina* exhibited the highest antifungal capacity across

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COMPARISON OF KENAF GROWTH AND PRODUCTIVITY IN POLLUTED VERSUS CLEAN FIELD CULTIVATIONS

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Kenaf (*Hibiscus cannabinus* L.) is an annual spring crop from the Malvaceae family that has attracted significant global attention due to its cost-effectiveness, adaptability, and ease of management compared to other fiber crops. The global kenaf market is projected to surpass USD 854 million by 2025 due to its numerous industrial applications (paper and pulp, fabrics, textiles, biocomposites, insulation mats, absorption materials, animal bedding, etc.). The potential of this crop when cultivated in polluted soils seems very promising due to the increased market demand and the corresponding release of agricultural lands. Field experiments were conducted at an AUA field in Lavrio, Attika, Greece, which was polluted with total concentrations of Cd (12 mg kg^{-1}), Ni (196 mg kg^{-1}), Pb (4782 mg kg^{-1}), Zn (3602 mg kg^{-1}), and Sb (75 mg kg^{-1}). At CRES unpolluted field at Aliartos (160 km NW of Lavrio) was also used as control. Two varieties of kenaf (HC 95 and HC3), three irrigation levels (I0: 0%, I1: 50%, and I2: 100% of ET) and three fertilization levels (F0:0 kg, F1:30 and F2:60 kg of urea per ha) were tested. The variety HC3 was better established and developed in both fields. In addition, the combination I2 X F2 was the most effective, as expected. In the polluted site, all plants were smaller and thinner compared to those in Aliartos, reaching a maximum height of 210 cm, stem diameter of 16.7 mm, and dry weight yield of 12.3 ton ha^{-1}. The corresponding values in the unpolluted site were 340 cm, 21.4 mm, and 27.8 ton ha^{-1}, respectively. Therefore, kenaf demonstrated a relative tolerance when cultivated in polluted sites, showing reduced growth and production. However, since it still produces higher yields compared to other fiber crops, it could be effectively utilized in phytoremediation plans.

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ENVIRONMENTAL IMPACT ASSESSMENT OF LOW INDIRECT LAND USE CHANGE (ILUC) INDUSTRIAL CROPS TO BIOENERGY, BIOFUELS AND BIOPRODUCTS

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Dedicated crops represent an important feedstock to decarbonise the energy sector and to meet the no net emissions of greenhouse gases by 2050, as set by the European Green Deal. Indeed, dedicated crops are renewable and sustainable feedstocks for energy and materials, associated with energy supply diversification, greenhouse gas savings and mitigation of problems related with materials biodegradability. However, the greenhouse gas performance of biomass to energy, biofuels and bio-based products, can be negatively impacted by Indirect land use change (ILUC) effects. In fact, the increasing demand for biomass, associated with technological development and the Green Deal European targets, may increase the competition for land, threatening food security. Consequently, cultivation of industrial crops on marginal land is repeatedly suggested as an approach to minimize land use competition with food crops and land use change controversies. MIDAS project (Utilization of Marginal lands for growing sustainable industrial crops and developing innovative bio-based products, funded by the European Union under Grant Agreement No. 101082070) aims to develop, evaluate and optimize sustainable low-ILUC feedstock by developing selected industrial crops and cropping systems on European marginal agricultural land in a climate-resilient and biodiversity-friendly way to support feasible bio-based value chains. In this framework, *Miscanthus* spp. and hemp (*Cannabis sativa* L.), were the selected crops to be studied in the project, due to their tolerance to marginal soils and potential for bioenergy, biofuels and bioproducts production. Therefore, the objective of this work was to determine the local and site-specific environmental impacts associated with the cultivation of these crops in marginal soils. The study was developed and applied to the cultivation phase of the different crops in different types of soil (good quality soil, marginal soils, contaminated soils), using environmental impact assessment (EIA) protocols. Preliminary assessment of the results suggests that growing these crops in marginal soils provide benefits regarding soil properties and erodibility. Miscanthus and industrial hemp showed benefits related to the biological and landscape diversity, due to the higher density of the biomass that provides higher coverage to wildlife. Impacts associated with water resources and N-fertilizer related emissions were higher in industrial hemp, but impacts associated with pesticide related emissions were low to both crops studied. The use of appropriate management practices (e.g. adequacy between crop and location, fertilizers balanced application) and innovative farming systems (e.g. intercropping, agroforestry) established on marginal land at farm level may reward biological diversity index and the impact on the soil quality index.

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VALORIZATION OF LIGNOCELLULOSIC RESIDUES AS A SOURCE FOR LIGNIN PRODUCTION

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Lignocellulosic biomass, composed of cellulose, hemicellulose, and lignin, is a highly abundant and renewable resource derived from agricultural, forestry, and industrial processes. Its importance lies in its potential to serve as a sustainable feedstock for producing biofuels, chemicals, and materials, thus contributing to the development of a biobased economy. Within this context, lignin, a complex organic polymer in lignocellulosic biomass, is crucial for the economic viability and sustainability of biorefineries. Lignin can be converted into a wide array of valuable products, including biofuels, bioplastics, and high-value chemicals. Therefore, the valorization of lignin can not only enhance the economic viability of bio-based industries but also may contribute to reducing waste and to the circular economy. Although there is a huge potential value for lignin application, its complex structure, heterogeneous molecular composition and difficulty in separation are delaying the progress on lignin research. One of the biggest challenges is to efficiently separate and extract lignin from cellulose and hemicellulose. Research is now focused on processes for lignin extraction. Treatments can be chemical or physical. For chemical pretreatments, different mechanisms of lignin extraction can be applied: dilute acid solvent, alkaline solvent, organic solvent, ionic liquids and deep eutectic solvent. For physical pretreatment, the mechanisms used mainly consist in using thermic processes or microwaves. Different methods have their benefits and drawbacks. It is important to understand the specifics of each treatment method and to select the right approach or a combination of several methods to achieve the highest process yield. This work focuses on the recent developments about the valorization of lignocellulosic biomass and wastes as a source of lignin, by discussing (i) how the characteristics of different biomasses and residues influence the lignin properties, (ii) treatments and extraction procedures, (iii) new technological applications. Eventually, the deep knowledge of the current development of this technology and a critical assessment of the limitations and future opportunities can allow science to progress.

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ADVANCES IN MICROENCAPSULATION OF FERTILIZERS: ENHANCING NUTRIENT EFFICIENCY AND SUSTAINABLE AGRICULTURE

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The growing population is driving up the demand for food, but the inadequate efficiency of traditional fertilizers is constraining crop production. Moreover, the inadequate use of fertilizers is also posing a risk to the ecosystems, especially when there is a surplus of nutrients given to the crops. This surplus can be leached to ground and surface waters and contaminated water streams. Micro and nanotechnology-based fertilizers represent a novel strategy for boosting agricultural output and show great potential as viable options in the fertilizer industry, as they can significantly enhance nutrient retention and promote optimal growth. This work explores recent advancements in the field of microencapsulation applied to fertilizers, with a primary focus on improving nutrient efficiency and promoting sustainable agricultural practices. Microencapsulation techniques offer innovative solutions to address challenges related to nutrient loss, environmental impact, and inefficient fertilizer utilization in traditional farming practices. The review highlights key developments in microencapsulation technologies, including encapsulation materials, methods, and their impact on nutrient release dynamics. The integration of microencapsulated fertilizers in agricultural systems not only enhances nutrient efficiency by providing controlled and targeted nutrient delivery but also contributes to sustainable agriculture by minimizing adverse environmental effects. The synthesis of current research findings underscores the potential of microencapsulation to revolutionize fertilizer management, fostering a more environmentally friendly and economically viable approach to agricultural practices. Also, a focus will be given to the production of materials for microencapsulation that are biobased and produced from lignocellulosic and fiber crops and wastes.

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GREEN SAFETY ANALYSIS

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The need for more ecological and biodegradable materials, and of renewable origin represents nowadays a key focus of the scientific community to combat the massive use of non-renewable and non-biodegradable resources that are contributing to severe levels of pollution. Lignocellulosic crops are rich in cellulose, hemicellulose, and lignin, representing, therefore, an important feedstock to multiple value-added products, capable of substituting the fossil feedstocks. To produce lignocellulosic feedstocks, factors like global trade, socioeconomic shifts, technology, urbanization, and agriculture practices play a significant role. This complex theme is further influenced by climate change, negatively impacting plant and animal health. Moreover, the processing of the lignocellulosic biomass to obtain bio-based products, should also follow green protocols. In addition, to evaluate the quality of soils and crops, analytical methods are crucial, but they often place a burden on the environment. This work explores the integration of green analytical methodologies for crops analysis. These 'Green' or sustainable analytical methodologies are based on the principles of Green (Analytical) Chemistry and can promote the health of the population and the well-being of our planet. However, legal, regulatory, and cultural challenges must also be considered. Metrics for assessing the "greenness" of analytical methods exist but are not frequently applied due to a lack of standardization and their complexity. Therefore, an overview of the current green analytical methodologies will be presented and categorized and strategies to measure their sustainability will be proposed and discussed. Green analytical chemistry is a research field to find affordable and sustainable solutions that can also need to assure the quality of the feedstocks for the biobased industries. Moreover, the implementation of green practices in the analytical sector, also contribute to the sustainability of cropping systems. Indeed, efforts to create biobased products should not inadvertently worsen climate change and pollution.

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MAXIMIZE RUBBER YIELD BY IDENTIFYING OPTIMAL SOWING AND HARVEST TIMES OF RUBBER DANDELION (*Taraxacum kok-saghyz)*

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The substantial global demand for natural rubber (NR) for the production of tires and other rubber products is primarily met by a single industrial crop, the *Hevea brasiliensis* L. tree from Asia. However, there is growing interest in the production of NR in temperate regions like Europe. The plant species *Taraxacum kok-saghyz* Rodin (Tks) has the potential to contribute to the NR supply, offering high-quality rubber from its roots and a good adaptation to regional conditions in Germany. Nevertheless, to fulfill the demand for NR through the use of Tks, numerous ongoing breeding programs are focused on increasing the rubber content and biomass of the plant itself. However, there is a paucity of knowledge regarding the plant's performance and its yield potential in agricultural production, which is subject to the influence of various factors, including the timing of sowing and harvesting. The objective of our project is to identify the optimal sowing and harvesting times to maximize rubber yield. A field experiment was therefore conducted at two locations in northeast and central Germany from 2022 until 2023. The experiment involved sowing breeding material of Tks at seven dates in summer and autumn, from August until October in 2022 and five dates in spring, from March until May in 2023. Each plot that varied in sowing time was harvested on a monthly basis from March to November 2023. The harvested material was utilized to identify root dry mass, rubber content and rubber yield over time. Results of the analysis of the sowing and harvest dates will be presented.

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ASSESSMENT OF ARGENTATINS' CYTOTOXIC ACTIVITY AGAINST PROSTATE CANCER CELL LINE (DU-145)

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In recent years, there has been a growing interest in research focusing on the utilization of plant compounds for the development of chemotherapeutic agents. This approach has been promoted due to the chemical and biological diversity offered by plants, producing a wide variety of bioactive compounds with therapeutic potential. Recent scientific investigations have turned attention towards the bioactive properties of argentatins, compounds found abundantly in guayule (*Parthenium argentatum* A. Gray), showing cytotoxic activity on different cancer cell lines. In this context, the cytotoxicity of argentatin A and argentatin B, the most abundant argentatins, was evaluated against the prostate cancer cell line DU-145, never tested before. The viability assay carried out by the MTT reaction demonstrated that both compounds, in monotherapy or in combination, have a high cytotoxic activity at low concentration for a natural compound. In monotherapy, the results agreed with previous studies with others prostate cancer cell lines such as PC3, argentatin A shows a lower IC_{50} (19,3 μM) than B (29,4 μM). The combined treatment revealed a mild synergistic effect, with a lower IC_{50} (9,5 μM of each compound) than the monotherapy. The remarkable differences between both argentatins, in addition to the reported synergistic effect, open the door to investigating potential mechanisms of action, exploring new, more specific treatments against prostate cancer by natural compounds or its derivatives.

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GUAYULIN A: NEW POTENTIAL ACTIVE INGREDIENT IN COSMETICS FROM GUAYULE (*PARTHENIUM ARGENTATUM* A. GRAY)

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Guayulin A ([(1R,2S,4Z,8Z,10S)-4,8,11,11-tetramethyl-2-bicyclo[8.1.0]undeca- 4,8-dienyl] (E)-3-phenylprop-2-enoate) is a key sesquiterpenic component of guayule resin whose commercialization could spur the feasible industrial-scale of guayule (*Parthenium argentatum* A. Gray) in European semi arid regions. As a sesquiterpene, this compound may exhibit properties such as antibacterial or antioxidant, making it a candidate ingredient in the cosmetics sector where natural alternatives are raising interest. However, the controversy about its potential allergenic risk is unfolding. On the one hand, an early study claims that guayulin A produces skin sensitization in Guinea pigs. In contrast, a robust study demonstrated that it did not generate any dermal irritation toxicity by itself in mice, and authors affirm that the probability of guayule rubber triggering sensitization due to the presence of guayulins is extremely remote. A comprehensive study of guayulin A was undertaken to determine its cosmetic potential and establish its safe dosage for human use. In this context, trials have been conducted on epithelial cells (HaCat) assessing the following parameters: 1) cytotoxicity by the MTT assay, a colorimetric method which correlates with cell survival; 2) antioxidant properties using a fluorescent-based method which detects ROS sensitivity through dichlorofluorescin diacetate (DCFH); and 3) regenerative capabilities using wound healing scratch tests conducted simulating in vitro skin damage to observe cell repopulation ability. Guayulin A safety was also tested *in chemico* with the certified test, "The Direct Peptide Reactivity Assay (DPRA)". Results showed that guayulin A exhibited an IC_{50} cytotoxicity index around 120 µM in keratinocytes (HaCat). However, cosmetic applications require the use of non-cytotoxic doses, which is the reason why 10% of cell death was established as an allowed limit and doses below 30 µM were selected. Antioxidant activity assays yielded encouraging results since guayulin A displayed significant antioxidant activity at low concentrations (10 µM). Furthermore, skin regeneration responses varied with different compound doses and to ensure that skin sensitization did not occur at these concentrations, DPRA was assayed. Although the commercialization of guayulin A as a cosmetic ingredient could enhance the value of guayule crops, the contradictory skin sensitization studies make it necessary to focus on tests that guarantee guayulin A safety and efficacy for human use.

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EFFECT OF ARGENTATINS ON ADIPOGENESIS IN INFLAMMATORY CONDITIONS

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Obesity is a pathology of growing importance in the world due to its high prevalence and its association with numerous comorbidities, including cardiovascular disease, Type 2 diabetes and certain types of cancer. It is characterized by excess body fat resulting from an imbalance between caloric intake and energy expenditure. Chronic inflammation appears to be one of the key factors in the onset, progression, and transition of obesity. Adipose tissue is considered an endocrine organ capable of secreting proinflammatory and anti-inflammatory molecules, known as adipokines. Analyzing the expression profile of obesity related proteins is essential for understanding the roles these molecules play in obesity per se and associated illnesses, such as diabetes and cardiovascular disease. Current anti-obesity pharmacology often produces adverse effects, so research into the development of natural products for the treatment of obesity is one of the current challenges. In this regard, the anti-obesity effects of several phytoconstituents have been explored for decades. Our aim is to determine whether argentatins (ARGs) A and B derived from guayule (*Parthenium argentatum* A. Gray) have effects on the inflammatory response obesity associated. For this purpose, the differentiation process (adipogenesis) of 3T3-L1 adipocytes was activated in the presence and absence of each of the ARGs at a concentration of 5µM, at which they had no effect on cell viability according to the MTT assays. To simulate an inflammatory state scenario, experiments were also carried out in the presence of lipopolysaccharide (LPS), an inducer of inflammation. The relative expression levels of 5 adipokines (adiponectin, hepatocyte growth factor (HGF), Lipocalin-2, Pref-1 and resistin), were determined using the mouse adipokine array (bio-techne, RD systems) in culture supernatants. The arrays were revealed by chemiluminescence using a 6-minute exposure. Our results indicated that LPS decreased the levels of adiponectin, an anti-inflammatory adipokine, while ARGs A and B increased these levels both in the presence and absence of LPS. As for HGF, a protein that plays an important role in adipose tissue expansion and function, ARG A decreased its levels only in the absence of LPS, whereas ARG B decreased its levels only in the presence of LPS. In addition, while ARG A decreased the levels of Lipocalin-2, a proinflammatory adipokine, with and without LPS; ARG B only did so in the presence of LPS. Both ARGs increased the levels of Pref-1, an inhibitor of adipogenesis, only in the presence of LPS. In the case of resistin, a proinflammatory adipokine, ARG A only decreased its levels in the presence of LPS, whereas ARG B did so in both situations. In conclusion, ARGs appear to have an anti-inflammatory effect that could potentially reduce obesity-associated inflammation. The differences between the results obtained for each ARG indicate that their mechanisms of action could be different. These findings open new avenues for research and development of natural compound-based therapies for the management of obesity.

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ULTRASONIC TREATMENT INCREASES GUAYULE (*PARTHENIUM ARGENTATUM* A. GRAY) SEED GERMINATION

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Guayule (*Parthenium argentatum* A. Gray) is a rubber producing shrub native to the Chihuahuan region of Mexico and the U.S. Southwest. Guayule is an alternative source of natural rubber for tire applications and critical materials used by various stakeholders in the United States and other countries. Seed dormancy is prevalent for guayule. Several treatments have been identified to improve guayule seed germination including conditioning them in solutions containing gibberellic acid, or with oxidizing agents such as calcium hypochlorite, hydrogen peroxide or sodium hypochlorite. In this study, the effect on germination of ultrasonic treatments in combination with gibberellic acid was determined. Seeds of diploid and polyploid guayule were sonicated at 44kHz for 15, 20, and 30 min and their germination percentages at 7 and 14 days on paper media and soil were compared to non-treated seeds. The seedling vigor in terms of seedling height was also compared among treatments. Sonication significantly increased soil germination at 7 and 14 days while there was no difference when seeds were germinated on paper media. Seedling heights were found to be greater on treatments from sonication compared to non-sonicated controls. This improved germination characteristic is important in guayule research and development activities, especially in guayule genetic improvement and agronomic studies where establishment and propagation of an adequate number of plants of certain genotypes for experiments are crucial.

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ANTIOXIDANT AND ANTIMICROBIAL POTENTIAL OF EXTRACTS FROM *Myrtillocactus geometrizans*

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Food and crops are under constant threat from a variety of microorganisms. Among these, fungi pose a significant threat, impacting 20% of annual agricultural production. Examples such as *Fusarium oxysporum* and *Aspergillus niger* cause considerable damage to crops as well as staple foods. Implementing effective strategies to control these pathogenic fungi is crucial. In this regard, plant extracts have emerged as a promising alternative to natural fungicides. The objectives of this study were to evaluate the antioxidant and antifungal potential of three extracts of *Myrtillocactus geometrizans* (Mart. ex Pfieff.) Console (known as garambullo) obtained through conventional agitation (AE: aqueous extract, HE: hydroalcoholic extract 50:50 ethanol:water, and EE: ethanol extract), as well as to identify phenolic compounds through ultra high-performance liquid chromatography (UHPLC). The results revealed differences in the content of total phenolic compounds, with the HE standing out with 4.7±0.9 mg gallic acid equivalents (GAE)/g, followed by the AE (3.1±0.9 mg GAE/g), and EE (3.1±0.3 mg GAE/g) extracts. Regarding antioxidant activity, the HE also excelled, with values of 4.4±0.6 and 28.2±2.5 mM Trolox/g according to the ABTS (2,2'-azino-bis-3-ethylbenzothiazoline-6-sulfonic acid) and (ferric reducing antioxidant power (FRAP) methods, respectively, compared with the AE (1.5±0.4 and 12.7±2.0 mM Trolox/g) and EE (1.9±0.4 and 13.1±3.4 mM Trolox/g) extracts. However, in the 2,2'-diphenyl-1-picrylhydrazyl (DPPH) method, the EE was the most prominent with 17.2±1.0 mM Trolox/g, followed by HE (13.9±0.9 mM Trolox/g) and AE (13.9±0.7 mM Trolox/g). UHPLC identified various interesting phenolic compounds, highlighting the presence of ferulic acid. In the antifungal evaluation against *F. oxysporum* and *A. niger*, EE showed 100% inhibition. This research reveals the antioxidant and antifungal potential of *M. geometrizans* extracts, demonstrating the influence of the solvent extract on its bioactivities, and serves as a reference for future applications and product development in the agricultural and food industries.

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BIOSTIMULANT EFFECT OF PLANT EXTRACTS FROM ARID AREAS ON CHILI SEEDS

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The utilization of plant extracts in agriculture has the potential to enhance crop resilience to adverse conditions. Research has shown that extracts can enhance plant tolerance to extreme temperature fluctuations, aiding in mitigating the impacts of global warming. Moreover, their application has been effective in repelling pests, preventing and managing diseases, reducing reliance on chemical pesticides and fostering sustainable agricultural practices. Plant extracts also possess the capacity to stimulate plant biomass growth, resulting in a significant increase in crop yield and production, which is critical for ensuring food security amidst escalating global demand. The objective of this study was to evaluate the biostimulant effect of extracts from *Eysenhardtia texana* and *Rhus mycrophylla*, traditional plants used in Mexican folk medicine, on jalapeño bell pepper (*Capsicum annuum* L.) seedlings. Leaves of *R. mycrophylla* and *E. texana* were collected in Coahuila State, Mexico, based on geographic information obtained from online databases, and two potential distribution maps for both species were generated. The collected leaf samples underwent a process of drying, grinding and sieving to obtain uniform particles (mesh no. 20), facilitating the extraction of active compounds. The raw material was characterized following the tests established by the Official Method of Analysis (AOAC). Extracts were prepared using water and ethanol as solvents through conventional agitation, and physicochemical characterization was conducted. The analyses performed revealed the presence of proteins (19.0±0.5% and 13.9±0.1%), lipids (7.7±0.9% and 7.4±0.8%), ashes (5.9±0.8% and 5.5±0.1%), and crude fiber (11.4±2% and 4.8±4.0%) in the leaf samples from *E. texana* and *R. microphylla*, respectively. This composition suggests the potential biostimulant activity of both plants. Regarding the plant extracts, the ethanol extract of *E. texana* exhibited the highest concentration of total phenolic compounds (21.0±3.7 mg gallic acid equivalents/g); while both aqueous and ethanol extracts of *R. microphylla* demonstrated higher antioxidant activity by the DPPH (2,2'-diphenyl-1-picrylhydrazyl) method. Preliminary results suggest the potential of the plant extracts from both species to promote plant biomass growth in chili seedlings and improve their performance under adverse conditions.

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BIOACTIVE PROFILE OF *Eysenhardtia texana* LEAF EXTRACTS USING DEEP EUTECTIC SOLVENTS (DES): CHARACTERIZATION AND OPTIMIZATION

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Mexico features a rich diversity of plants with bioactive potential, highlighting those from arid and semi-arid areas. One of these species is *Eysenhardtia texana* (Palo dulce or Riñonera de Texas), predominantly found in Coahuila, Nuevo León, and Tamaulipas in Mexico, as well as the Rio Grande Valley in the United States. This plant has long been recognized for its diuretic, antidiabetic, antioxidant, anti-inflammatory, and antimicrobial properties. However, research on its bioactivity remains limited. In this context, deep eutectic solvents (DES) offer a sustainable and efficient alternative for extracting bioactive compounds from plants compared to traditional solvents, owing to their non-toxicity and biocompatibility. This study delves into the bioactive profile of *E. texana* leaf extracts using DES, a novel extraction approach. Five DES were meticulously selected for extracting total phenolic content (TPC), total flavonoid content (TFC), and antioxidant capacity from *E. texana* leaves through conventional agitation extraction. These initial extractions aided in identifying the most efficient DES, guiding the subsequent factorial experimental design to evaluate the effects of two independent variables (temperature and time) for their microwave-assisted extraction. Extraction efficiency was determined by assessing TPC, TFC, and antioxidant capacity by the 2,2'-azino-bis (3-ethylbenzthiazo-line-6-sulphonic diammonium acid (ABTS)), 2,2-diphenyl-1-picrylhydrazyl (DPPH), and ferric reducing antioxidant power (FRAP) assays. Optimal extraction results were achieved with choline chloride:acetic acid:water (1:1:10) as the optimal extraction solvent. Under these optimal conditions, the following values were obtained: TPC: 76.20 mg gallic acid equivalents/g, TFC: 38.07 mg rutin equivalents/g, ABTS: 54.82 mg Trolox equivalents (TE)/g, DPPH: 306.05 mg TE/g, and FRAP: 118.62 mg TE/g. These results underscore the potential of DES to effectively extract valuable bioactive compounds from *E. texana*, suggesting their promising applications in the pharmaceutical and agri-food industries while promoting the sustainable utilization of plants from arid and semi-arid regions.

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SELECTION OF ADAPTED VARIETIES OF HEMP (*Cannabis sativa L.*) TO GRAIN PRODUCTION IN SPAIN

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Industrial hemp (*Cannabis sativa* L.) is mainly grown for industrial uses (fiber, grains, and seeds). In recent years, the area dedicated to the cultivation of hemp in Spain has multiplied by eight since 2016 (from 61 to 510 hectares), according to 2020 data from the Spanish Agrarian Guarantee Fund (FEGA). Therefore, it is still necessary to develop and promote agricultural technology for the cultivation of hemp, to make it a profitable crop in Spain, and the first step is selection of the best adapted varieties. Furthermore, the current situation of climate change detects an opportunity in the cultivation of hemp, to validate the positive impact that could have new sustainable management techniques on the CO_2 capture of farms. The aim of this study was to evaluate the agronomic adaptation and grain production of seven varieties of industrial hemp (*Cannabis sativa* L.) for two successive years, as an alternative source of nutritional compounds. All varieties are included in the EU common catalog of varieties of plant species, and they were chosen due to their good field adaptation and productivity. In 2022, five varieties were planted in Épila (42.123251825428405, -1.123220164595737), Spain in a field with sprinkler irrigation, and surface of 0.1 ha/variety. Futura 75, Futura 83, Felina 32, Earlina 8 FC and Henola. Once the crop was fully developed, the seed was collected manually by variety, and within a representative sampling of 10 m^2 in two replicates. In 2023, the field assay was established in the same field with the 2 best varieties of 2022 (Earlina and Henola), and with two new ones, Ferimon and CFX2. The parameters evaluated were plant height (cm), seed yield (g/plant), field performance (kg/m^2), longitudinal seed diameter (LSD, mm), transverse seed diameter (TSD, mm), germination rate in vitro (%) and CO_2 capture capacity (t/ha). Within the parameters studied there were significant differences between the varieties, which may offer technological properties of different kinds for the agri-food industry. This fact makes it difficult to select a single variety currently, requiring further studies with more varieties and corroborating its characteristics in successive campaigns.

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CHARACTERIZATION AND PRE-TREATMENT OF OLIVE MILL BY-PRODUCTS AND EFFLUENTS FOR DEVELOPMENT OF BIOREFINERY SOLUTIONS

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Olive (*Olea europea* L.) mills generate vast amounts of wet bagasse that is generally transported to centralized valorization units that separate excess water, dry the decanted bagasse and use it as a source of olive pomace oil and solid biofuel. This approach implies the transport of significant amounts of water, an option that leads to dispersion of some of this water in the environment and increases the carbon footstep of the overall process. On the other hand, direct drying of large volumes of wet bagasse is a source of important emissions of volatile organic compounds and particles that have a negative impact on environmental conditions and quality of life of neighboring populations. In this work, are explored alternative scenarios for the valorization of the by-products and effluents from olive mills including olive stones, olive tree leaves, wet bagasse and vegetation water (recovered from olive storage units). Wet bagasse was filtered, dried and fractionated by milling and sieving in order to isolate an olive stone-rich fraction and a pulp-rich fraction. The liquid effluents (filtered olive mill wastewater and vegetation water) were subjected to an evaporation-condensation process in order to recover water and volatiles isolating a solid fraction containing minerals and high molecular weight organics. All solid products were characterized for proximate, ultimate and mineral composition. Heating value was calculated to evaluate their solid fuel quality. The recovered water was characterized for pH, acidity, total nitrogen and chemical oxygen demand. Considering mass and energy balances of these fractionation and stabilization processes, possible scenarios for olive mill biorefinery solutions are proposed and discussed.

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PRICKLY PEAR: A VERSATILE RESOURCE FOR NOVEL FOOD PACKAGING SOLUTIONS

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Cactus plant (*Opuntia* spp.) is a versatile crop that emerges as a viable solution to help in the mitigation of climate change impacts in agriculture. This xerophytic plant, well adapted to arid and semiarid regions, offers a promising alternative to be used in degraded soils, which are otherwise unsuitable for traditional crops. Prickly pears, the spiny and succulent fruits from the cactus plant, are mainly used for human consumption as a whole or incorporated into other food products such as jams and jellies. It is mainly composed of water, sugar and fibers. Also, prickly pears are rich in several bioactive compounds for instance, ascorbic acid, phenols, flavonoids, and betalains. Betalains can be extracted from prickly pears to be used as natural food colorant as an alternative source to beetroot (*Beta vulgaris* L.), commonly used for this purpose. Moreover, these pigments have the potential to be used as a sensor in food packaging as a pH indicator. Thus, the aim of this work was to characterize prickly pear fruits (red and orange variety), to evaluate the potential of development of extracts rich in betalains for further test as pH food indicator. Prickly pears were characterized in terms of physical and chemical characteristics and bioactive properties (ascorbic acid content, total phenolic compounds, antioxidant activity and betalain content (indicaxanthin and betanin). The fruits were separated and analyzed into peel and pulp for comparison. For the bioactive properties analysis, aqueous extracts were performed. The fruits are mainly composed of water (85%) and the peel showed a higher ash content when compared with pulp, for both varieties. Fruits can be characterized into low acid fruits, showing a pH 6.16±0.13 (red variety) and 6.48±0.30 (orange variety). The content in total soluble solids was similar in both varieties. Regarding bioactive composition, fruits showed relevant content in phenolic compounds (874.81 mg of gallic acid equivalent/100g- red peel) and antioxidant activity (6132.66 μmol equivalent to Trolox/ g of dry fruit – red peel). In terms of betalains, red fruits showed a higher content in indicaxhathin (52.62 mg/kg dry basis in peel), that is more predominant in the red variety than in the orange variety (19.57 mg/kg dry basis in peel). Betanin content was also higher in red fruits than in orange fruits. Therefore, prickly pears constitute a good source of betalains, especially the red variety and have promising use as a sensor in food packaging as a pH indicator. Preliminary tests are being conducted with extracts to understand the stability of betalains along time together with the amount needed to sense changes in color. This feature allows not only the manufacturers but also the consumers to know more about the quality and safety of a food product, contributing to the decrease of food waste.

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IMPACT OF ORGANIC AMENDMENTS AND SYMBIOTIC MICROORGANISMS ON EUCALYPTUS GROWTH IN ALJUSTREL MINING PARK

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The soils of the Aljustrel Mining Park present significant challenges for agricultural productivity due to their acidic characteristics and high heavy metal content. However, these marginal lands offer a potential opportunity for the cultivation of energy crops, resilient to adverse conditions. A pot experiment was conducted to evaluate *Eucalyptus globulus* growth in terms of height and biomass production using soils from the Aljustrel Mining Park. *Eucalyptus* was chosen for its rapid growth and high potential for biomass production, as well as its demonstrated tolerance to soils contaminated by potentially toxic elements (EPTs). The study focused on the use of organic amendments and arbuscular mycorrhizal fungi (AMF) to evaluate their effects in crop growth. The organic amendments used included municipal solid waste (MSW) compost and biochar derived from forest biomass, applied alone and in combination at equal doses (64g/kg). For these treatments, replicates were made including inoculation of the AMF, *Rhizoglomus irregulare*. The results indicated significant improvements in *Eucalyptus* productivity with the isolated application of biochar and the isolated application of MSW compost. Regarding plant height, only the application of biochar demonstrated a positive influence. On the other hand, the interactions between the different amendments, including the treatments in which inoculation with the AMF was performed, did not present significant differences compared to the controls. This highlights the need for more detailed analyses of biomass to understand which properties can be affected by both the combination of different additives and the addition of arbuscular mycorrhizal fungus (AMF).

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CAMELINA AND CHICKPEA INTERCROPPING: SOIL IMPROVEMENT, WEED CONTROL AND MOISTURE MAINTENANCE

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The practice of intercropping has been demonstrated to be a sustainable and beneficial agricultural method, particularly in regions with limited resources. In this context, the combination of intercropping chickpea (*Cicer arietinum* L.) and camelina (*Camelina sativa* (L.) Crantz), two crops of agricultural interest in the food and energy industry, have been investigated with the aim of improving soil health, controlling weeds and maintaining soil moisture. Camelina is an oilseed plant that has been demonstrated to improve soil structure and fertility. The deep roots of the plant act as a natural subsoiler, allowing for improved soil penetration and aeration, which is beneficial for chickpea development. Camelina is an effective mulch that competes with weeds for light, space and nutrients, thereby reducing the need for chemical weed control. This competition significantly reduces the proliferation of weeds, thereby reducing the need for the use of herbicides and contributing to the sustainability of agriculture. Due to its allelopathic effect, which is present in cruciferous plants, it is not particularly attractive to animals, which would benefit the chickpea crop. Another significant advantage of intercropping camelina and chickpea is the maintenance of soil moisture. The soil cover provided by camelina reduces water evaporation from the soil, thereby maintaining more stable moisture levels. This is of particular importance in regions with limited or irregular rainfall, where water use efficiency is of paramount importance. On one hand, the benefits of intercropping have already been evaluated on a one-hectare plot of short-cycle camelina with chickpea. On the other, the benefits of intercropping are currently being evaluated on larger areas of two varieties of short-cycle camelina with chickpea. In the future, the sowing of one long-cycle camelina variety will be evaluated in order to ascertain the feasibility of growing chickpea on the same land at a later date. In conclusion, the intercropping of camelina and chickpea represents a viable solution for improving soil health, controlling weeds and maintaining moisture, all of which are essential for agricultural sustainability. This system promises to be an effective strategy for farmers seeking more sustainable and productive farming practices.

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BIOEQUIP PROJECT: NEW TECHNOLOGIES FOR THE EXTRACTION OF BIOACTIVES AND PRODUCTION OF BIOCOMPOSITES AND THEIR ASSOCIATED EQUIPMENT

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The BioEquip project is part of the Mobilizing Agenda for Business Innovation, called Produtech R3, focusing on the development of industrial solutions aimed at extracting bioactives and manufacturing raw materials from biomass covering the entire value chain for the development and implementation of new industrial production units, that is, the factories of the future for the production of biomaterials. This project is divided into the development of three technological PPS (products, processes or services). The first PPS aims to develop: i) a new pilot line of ultrasonic reactors for the production of cellulose nanocrystals and extraction of curcumin, using a faster and more efficient process that uses catalysis; ii) implementation of methodologies and quality control systems for the production of bioactives; iii) a new composition line for the production of biocomposites validated for food contact with advanced (online and inline) sensing and control systems. The second PPS aims to develop a set of modular tools and sensors that can be integrated and adjusted in laboratory extruders (industrial and academic R&D) to provide the capacity for real-time monitoring of the characteristics of the material to be processed. Online and inline approaches are considered, to evaluate the dispersion of charges using optical spectroscopy and rheometry. The third PPS aims to develop the conceptualization, manufacture and integration of new ozone generation and dispersion equipment for the production of ozonized oils for the health and cosmetics industries, to provide the following products: a) a low-cost for the production of oils for application in medicine establishments and cosmetics manufacturers; b) vegetable oils in commercial formulations, in accordance with the REACH regulation. With this integrated approach and total focus on energy efficiency and sustainability in terms of the treatment of materials and production waste, BioEquip will provide the first national pilot line for the manufacture of bioactives and biocomposites from these, which will serve a wide range of sectors national strategies (automobile, packaging, electronics, etc.), providing a transformation of value chains from an international importing context to a regional exporting context. Advances, constraints and outcomes of the project (that will be finished in December 2025) will be presented.

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THERMOCHEMICAL CONVERSION OF CROP RESIDUES IN THE PROVINCE OF HUÍLA, ANGOLA. IS IT POSSIBLE TO REPLACE THE FIREWOOD USAGE IN EVERY HOUSEHOLD?

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In recent years, the search for cleaner energy sources in Angola has been driven by the urgent need to reduce the dependence on fossil fuels for energy production. This movement has become even more relevant because of the increase in greenhouse gas emissions, especially by transport and industry sectors, placing the country in an environmental and socio-economic dilemma. Despite Angola's vast resources of hydroelectric power and fossil fuels, only 30% of the population has access to electricity. Mostly rely on firewood, which accounts for 65% of the country's primary energy consumption, and is consumed by around 80% of the rural population. Firewood is traditionally burnt in three-stone fires, which is an inefficient energy conversion, and harmful to health due to the emissions released. Given this scenario, there is a need to explore more sustainable alternatives to use biomass as an energy source for cooking. This work aims to evaluate different scenarios and technologies to promote more efficient conversion of biomass, reducing harmful emissions and the respective adverse health impacts. Two approaches were considered: (i) the partial replacement of firewood with agricultural residues, and (ii) the implementation of more efficient cookstoves capable of significantly reducing firewood consumption and polluting emissions. Residues produced from harvesting corn (*Zea mays* L.), millet (*Pennisetum robustum* Stapf & C.E.Hubb) and sorghum (*Sorghum bicolor* L., Moench) in the Huíla province were determined. Preliminary results indicate that crop residues can replace the firewood used by households to cook by 25% and, in some comunes, the production is enough to replace the firewood. However, it is important to recognise the challenges that arise from this energy transition. Switching to a more efficient technology requires a significant financial investment which may not be accessible to the vast majority of the rural population. In addition, it is necessary to build an infrastructure to store agricultural residues, which can also be an obstacle. It is therefore important to promote public policies that encourage, support and facilitate the transition to a cleaner and more sustainable energy source in Angola. These policies must consider economic, social and environmental aspects to guarantee equitable and sustainable development for all sections of the Angolan society.

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DEVELOPMENT OF DIGITAL TOOL FOR THE SUPPORT FOR SUSTAINABLE USE OF INDUSTRIAL CROPS IN RURAL AREAS

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Development of digital tools primarily serves to increase the knowledge regarding innovative methods of managing agricultural production, including crops and livestock. It is an answer to the growing demand for grassroots initiatives and knowledge sharing to address major challenges, such as improving resilience to climate change and the need to reduce greenhouse gas emissions while promoting a zero waste and closed-loop economy involving reuse of biomass. Industrial crops are an important part of crop production in Poland, e.g. rapeseed with 1078.1 thousand ha, which constitutes 9.8% of Polish crop production. As a result, Poland remains among the leading EU countries in rapeseed cultivation, processing and oil production. Rapeseed is commonly used for oil production; it can also be a substrate for the production biofuel. However, alternative uses of oil production by-products, including the so-called post extraction rapeseed meal, pomace and glycerol are not common. The meal can be used as an ingredient in livestock feed (as it is rich in protein). Interestingly, rapeseed has found application in the pharmaceutical and cosmetic industries, including production of soap, laundry detergents, varnishes and medicines. Thanks to the BBioNets platform, such practices can be disseminated on a large scale directly to farmers, or small producers, increasing their economic potential. BBioNets is a thematic network which aims to promote the results of the work carried out by the Operational Groups (OGs) of EIP AGRI with regard to the management or processing of agricultural and forest biomass through the use of biotechnology (BBT), that is, technologies or practices using non-food raw materials or principles of the closed-loop economy - or both - to provide a variety of products.

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