2030 Sustainable Development Goals

UMinho Research & Innovation Open Days

30-31 January 2024, Braga, Portugal

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DESIGN e PAGINAÇÃO de:
"2030 Sustainable Development Goals - UMinho Research and Innovation Open Days"
CAPA Nicolau Moreira
PAGINAÇÃO Tiago Farinha

EDIÇÃO UMinho Editora

LOCAL DE EDIÇÃO Braga 2025

ISBN DIGITAL 978-989-9074-65-1

DOI https://doi.org/10.21814/uminho.ed.195

2030 SUSTAINABLE DEVELOPMENT GOALS

UMinho Research and Innovation Open Days

30th-31st January 2024

Braga, PORTUGAL

University of Minho
uminho.pt

BOOK OF ABSTRACTS OF THE
UMINHO RESEARCH & INNOVATION OPEN DAYS

ADDRESSING THE 2030 SUSTAINABLE DEVELOPMENT GOALS

30-31 JANUARY 2024, BRAGA, PORTUGAL

This volume contains the abstracts of the poster and oral communications presented at the UMinho Research & Innovation Open Days, held in Braga, Portugal, between January 30th and 31st, 2024.

https://www.uminho.pt/PT/siga-a-uminho/Paginas/Detalhe-do-evento.aspx?Codigo=63074

Edited by **Eugénio Campos Ferreira** and **Sandra Paiva**

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SDG17 *Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development.*

FOREWORD

I am honoured to present the Book of Abstracts for the 1st edition of the UMinho Research & Innovation Open Days, held on the 30th and 31st of January 2024. This event marks a significant milestone in our shared journey to foster research excellence, innovation, and impactful collaborations within and beyond the University of Minho.

The Open Days serve as a unique platform to celebrate the achievements of our research community, highlight the breadth of expertise across diverse scientific domains, and promote a culture of interdisciplinary and international cooperation. This inaugural edition aligns with UMinho's mission to advance knowledge and innovation in response to societal challenges and global priorities, particularly the Sustainable Development Goals (SDGs) for 2030.

The thematic sessions, encompassing UMinho Research Highlights, Innovation Ecosystem, and International Cooperation, have offered participants a broad spectrum of insights. They reflect our commitment to addressing global challenges through research, with an emphasis on open science, ethical research practices, and impactful dissemination. The role of UMinho in the Portuguese Roadmap of Research Infrastructures and its collaborations with institutions like the University of São Paulo further underscores our leadership in fostering knowledge networks.

This Book of Abstracts compiles the research contributions presented by our PhD students mostly in poster format during the two-day event. These abstracts, organized by research units, represent the cutting-edge work carried out by our academic community and collaborators. A selection of posters was showcased during two dedicated pitch sessions, where students shared innovative solutions targeting the SDGs.

The abstracts illustrate a wide range of topics, from biotechnology and sustainable energy solutions to legal and psychological studies, reflecting the diversity and strength of our research ecosystem. Organized across UMinho's research units, they offer a clear overview of the interdisciplinary and impactful projects that define our institution.

On behalf of the organizing committee, I would like to extend my deepest gratitude to all participants, researchers, and stakeholders who have contributed to the success of this event. I also acknowledge the critical support provided by our innovation ecosystem partners, associate laboratories, and international collaborators.

We hope this compilation serves as a valuable resource for fostering future collaborations and advancing shared goals in research and innovation. May it inspire continued exploration and commitment to excellence in addressing the challenges of our time.

Eugénio Campos Ferreira
Vice-Rector for Research & Innovation

CENTRO ALGORITMI

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SUSTAINABLE INCENTIVES FOR PROCESS TOKENISATION IN THE PUBLIC SECTOR

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Keywords: Blockchain, Sustainability, Tokenisation

2030 Sustainable Development Goals: SDG4, SDG8, SDG12, SDG15, SDG16, SDG17

Digital transformation raises citizen expectations of governments' ability to deliver digital services. In the meantime, the trust and confidence of citizens in governments worldwide have been declining over the years, and the lack of transparency contributes to this depreciation.

However, before adopting a technology, organisations must assess whether it is adequate or optimal to automate their business problems. This work aims to describe and validate a model to help public organisations select the most suitable public sector business process to adopt blockchain, called tokenisation, covering several aspects, i.e., capabilities, requirements, sustainable incentives, and tokenisation outcomes.

In the blockchain's context, tokenisation means digitally representing tangible objects or electronic assets in blockchain, with transparency and trust, being an enabler and a booster of the accomplishments of the Sustainable Development Goals (SDG).

The research consolidates the results of four systematic literature reviews and applies structured interviews. The work adopts the lens of sociotechnical theory and process virtualisation theory. Also, the research design chosen is the multiple case studies to validate the model.

One of the reviews looked to identify aspects and benefits related to sustainability in selecting the most suitable public sector business process for tokenisation. The results consolidate eight sustainable incentives: behavioural incentives, process' standardisation, compliance issues, supply chain traceability, resource management, circular economy, credit management, and SDG monitoring.

These sustainable incentives were validated by 19 structured interviews with experts covering public sector specialists, blockchain professionals, and scholars. Therefore, it was possible to synthesize each sustainable incentive benefit from the respondents' perspectives and consolidate it as a Sustainable Process Tokenisation Model for the public sector.

The model was described and evaluated under the European Blockchain Service Infrastructure use case of Education Credentials. It remained demonstrated that the use case can contribute to SDG4, SDG8, and SDG17 by increasing the possibility of mobility around Europe for students and professionals and to SDG16 by promoting a solution of trust and transparency. Furthermore, the adoption of digital documents has the potential to reduce paper use, contributing to SDG8, SDG12, and SDG15.

In conclusion, the work demonstrated that blockchain applications in the public sector can contribute to sustainability. The sustainable incentives can be interpreted as critical variables of blockchain adoption to achieve SDG. Also, based on blockchain's characteristics and the public sector's function, it is possible to conclude that blockchain is an alternative solution that needs to be evaluated in each context, with proven sustainable potential.

PHOTOVOLTAIC ELECTRIFICATION OF OFF-GRID IN SCHOOLS AND HEALTH UNITS IN ANGOLA

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Keywords: Energy planning, Project evaluation, Angola

2030 Sustainable Development Goals: SDG3, SDG4, SDG7

Electricity generation and consumption play crucial role in the development trajectory of countries, particularly in Africa, where challenges related to accessibility, and sustainability persist. The big challenges faced by the majority of the African countries in providing reliable and affordable energy undermines the main objectives of achieving economic and social progress for the population.

Angola presents substantial endogenous renewable and non-renewable energy resources. Especially prominent among the renewable resources are hydro and solar energy in the country. Although the energy plans for Angola include the increase of renewable energy sources, access to electricity remains a fundamental challenge. With regard to the specific challenges faced by Angola, a comprehensive analysis is made of the current conditions of the electricity sector, the future outlook and the main challenges identified to ensure that Angola can move towards a cleaner energy transition with benefits for the entire population. Based on a critical review of the literature, a discussion is presented about the Angolan electricity sector with na emphasis on the prevailing social problems.

This study addresses in particular the case of distributed photovoltaics (PV) in Angola. We present a socioeconomic assessment of these projects including the evaluation of the economic interest of these projects and the analysis of their potential contribution to tackling local social needs at schools and health units. The results show that the low diesel prices in the country severely undermine the economic interest of the project. Fossil fuel subsidies discourage the replacement of old diesel generators with PV systems. However, significant health gains related to the reduced use of highly polluting diesel or increased electricity security of supply should not be overlooked, along with potential long-term social and economic gains that the establishment of a solar PV industry could bring to the country. Both opportunities and barriers for PV development are discussed to draw conclusions on the political implications of the research.

CENTRO DE BIOLOGIA MOLECULAR E AMBIENTAL

CENTRE OF MOLECULAR AND ENVIRONMENTAL BIOLOGY

CBMA

BIOPROSPECTION OF MARINE MICROORGANISMS AS A SOURCE OF INSPIRATION TO DESIGN NOVEL ANTIMICROBIAL PEPTIDES

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Keywords: Antimicrobial Resistance, Antimicrobial Peptides, Marine Microorganisms

2030 Sustainable Development Goals: SDG3

Antimicrobial resistance (AMR), one of the most serious global public health threats, is considered a priority issue for this century by the World Health Organization. Recent reports indicate that antibiotic-resistant bacteria caused 1.27 million deaths in 2019, and this number is estimated to exceed 10 million deaths/year by 2050. The rising incidence of drug-resistant bacteria and the slow pace of new antibiotic discovery highlights the urgent need for effective alternatives.

The vast and largely unexplored microbial diversity within the marine environment presents a rich source for discovering novel antimicrobial molecules. Antimicrobial peptides (AMPs) derived from marine microorganisms emerge as a promising class of new drug candidates, owing to their broad-spectrum activity and stability under physiological salt conditions.

Our research group established a biobank of marine microorganisms with potential antimicrobial activity against pathogenic bacteria. Selective media were used to isolate different microorganisms. Four ribosomal RNA regions were sequenced using Sanger Sequencing, allowing to distinguish 108 unique isolates from the original pool of 264, comprising 84 bacteria, 9 yeasts, and 15 filamentous fungi. The v3-v4 region of bacterial 16S rRNA gene and fungal ITS2 region were sequenced on Illumina paired-end platform, to unravel the microbial communities present in marine environmental samples.

Microbial isolates were screened for their antimicrobial activity against six pathogens of clinical relevance (*Escherichia coli*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Bacillus subtilis*, *Staphylococcus epidermidis* and *Klebsiella pneumoniae*). Among the 84 isolated bacteria, 75 demonstrated antimicrobial activity against at least one of the six tested pathogens. Remarkably, 5 isolates exhibited activity against all tested microorganisms, indicating their significant potential in addressing antimicrobial resistance. The cell-free supernatant from these cultures also displayed antimicrobial activity, suggesting the presence of antimicrobial compounds in the extracellular media. To identify the presence of AMPs, proteomic assays are being conducted with these supernatants aiming at the identification and characterization of potential secreted AMPs.

The identification of novel antimicrobial molecules from marine microorganisms holds the promise of providing innovative solutions against antibiotic resistance, paving the way for the development of a new generation of antibiotics.

CANDIDA ALBICANS ACETATE TRANSPORTER ORTHOLOGUES (ATOS): DOCKING AND EXPRESSION STUDIES

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Keywords: Alternative carbon sources, Candida albicans, Plasma membrane transporters

2030 Sustainable Development Goals: SDG3

In recent years, fungal pathogens have emerged as a significant global health concern. Among these pathogens, *Candida albicans*, a common opportunistic commensal microorganism, stands out as the leading cause of systemic candidiasis and nosocomial bloodstream fungal infections. *C. albicans* cells exhibit the capacity to colonize various parts of the host under abnormal conditions, especially in immunocompromised patients. One of the major features of this microorganism is its ability to adapt to environmental changes and utilize alternative carbon sources, such as acetate and lactate in glucose-poor settings of the host body. Plasma membrane (PM) transport proteins seem to play a significant role in the uptake of these substrates in *Candida* species. In *C. albicans* there are two categories of PM proteins for this purpose: Jen and Atos (acetate transporter ortholog) which are allocated respectively to the sialate: H+ symporter (SHS) and the acetate uptake transporter (AceTr) families with 8 Ato-like proteins, whose functions are still unknown.

We have generated *C. albicans* strains harboring Atos fused in the genome with GPP using the CRISPR-Cas9 system to evaluate the expression, subcellular, and trafficking of Ato transporters in distinct environmental conditions. We have characterized these Atos' expression patterns in various media containing different sole carbon sources, both in the presence and absence of amino acids. In addition, an *in-silico* analysis of Ato proteins was carried out to predict and characterize their three-dimensional structure, specificities, and docking with substrates. This study advances our knowledge on how the pathogenicity of *C. albicans* is directly influenced by the metabolism of specific nutrients (carboxylic acids) and by the regulation of PM carboxylate transporters, particularly Atos.

EFFECTS OF CELLULOSE POWER-PLANT WASTEWATER ON BENTHIC ASSEMBLAGES

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Keywords: Bioindicators, Organic Enrichment, Macrobenthos

2030 Sustainable Development Goals: SDG14

Benthic marine fauna plays an important role in several ecosystem processes such as the mineralization and cycling of nutrients, the transport of organic matter and oxygen through different layers of sediment, among others. Benthic assemblages are also highly sensitive to environmental conditions so its variations are probably the best available bioindicators to assess anthropic impacts on marine ecosystems. Europe governments adopted legal and administrative frameworks such as MSFD and WFD, establishing benthic fauna monitoring as a method of assessing ecosystem health. However, in the Portuguese coast these assemblages have been little studied, especially in the north region. Therefore, this work aims to assess the impacts of a cellulose power-plant effluent, located in Viana do Castelo, in the sublittoral benthic communities.

The main hypothesis is that areas near the effluent will present an impoverished benthic assemblage and as distance from the effluent increases the benthic assemblage will present a higher species number and lower abundances. Benthic assemblages and sediment samples were collected in different sites with increasing distances from the effluent to compare diversity, abundance and biomass. Concluding this work can lead to better understating organic enrichment effects on benthic assemblages and the proposition of better marine management frameworks.

GENERATION OF MOLECULAR TOOLS TO ANALYSE THE EXPRESSION OF MAMMALIAN MONOCARBOXYLATE TRANSPORTERS

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Keywords: Mammalian monocarboxylate transporters, Molecular tools, Plasmids

2030 Sustainable Development Goals: SDG3

Monocarboxylate transporters (MCTs) are a family of transporters that are essential for the import of monocarboxylates such as lactate, playing an important role in mammalian metabolism. This family contains 14 isoforms that differs in terms of tissue distribution, intracellular localization and regulation of expression, supplying the metabolic need of the respective tissue in which they are expressed. Given their importance, changes in their expression, activity or function can lead to a number of clinical manifestations ranging from mild disorders to severe diseases, such as cancer. The export of lactate from highly glycolytic tumor cells ensures the progression of glycolysis and prevents intracellular acidification. We hypothesize that the downregulation of MCTs in specific cellular environments might protect from certain types of cancer. To test this, several plasmids are being constructed, harboring MCT1 or MCT4 fused with fluorescent proteins, mCherry or GFP, at either the N or C termini. These constructions will be further transfected in specific human cell lines in order to analyze the trafficking and expression of MCTs at relevant metabolic growth conditions as well as after treatment with certain compounds. At the end of this work, we expect to characterize the conditions and mechanisms behind the endocytic trafficking of MCTs.

ZnO-Based Thin Films as High-Efficiency Antifungal Coatings

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Keywords: Antifungal coatings, ZnO-based thin films, Gold nanoparticles (Au NPs)

2030 Sustainable Development Goals: SDG3, SDG11

Microbial contamination on frequently touched surfaces presents a global challenge with implications for both public health and industry. Microorganisms adhere and proliferate on various inanimate surfaces, including tables, screens, and doorknobs. Insufficient and ineffective disinfection of these surfaces transforms them into reservoirs for microbial growth. The significance of high-touch surfaces in the transmission pathway of infectious diseases has been accentuated by the COVID-19 pandemic. Consequently, there is a pressing need for the development of antimicrobial coatings to reduce microbial adhesion, thereby contributing to the mitigation of pathogen transmission through surfaces.

This study focuses on developing ZnO-based coatings with antifungal properties. ZnO thin films were produced by reactive magnetron sputtering with different thicknesses and gold concentrations. Then, their antifungal activity was assessed by direct contact with the model pathogen, *Candida albicans*.

The developed thin films demonstrated significant antifungal activity, achieving an 80% reduction in cell viability, regardless of thickness, and for gold concentrations below 15.4 at.%. Post-deposition annealing at 600 ˚C induced the formation of superficial Au NPs in samples with C_{Au} ≥ 15.4 at.%, thereby enhancing the antifungal activity of Au-ZnO compared to as-deposited thin films. These findings suggest a surface antifungal activity of ZnO-based thin films and the synergistic impact of Au NPs.

Therefore, ZnO-based thin films exhibit high efficiency as antifungal coatings for diverse surfaces, protecting against microbial contamination.

TRANSCRIPTOMIC ANALYSIS OF *C. ALBICANS* CELLS IN DISTINCT METABOLIC CONDITIONS

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Keywords: Candida albicans, metabolic flexibility, alternative carbon sources

2030 Sustainable Development Goals: SDG3

Candida species are among the most common cause of fungal and nosocomial infections in humans. Their capacity to cause disease resides in the ability to grow within the host environment. To successfully proliferate in the human host, *Candida* cells need to adapt to a broad range of constraints, including changes in nutrients, environmental pH, or attack of the immune system. All of these constraints require rapid and coordinated changes in metabolism and physiology. In most studies, *C. albicans* cells are grown on artificial media conditions that do not mimic physiological environments, leaving important physiological effects largely unexplored. We have previously shown that growth in the presence of alternative carbon sources, such as lactate influences the behavior of *Candida* cells in antifungal drug resistance.

In this work, we have performed a whole transcriptome analysis of *C. albicans* cells under relevant environmental conditions, using RNA-seq. Here, *C. albicans* cells were grown in the presence of lactic acid, an alternative carbon source frequently presented to *C. albicans* in the host environment, either at pH 5 or pH 7, and several samples were retrieved and analyzed to decode the pathogen metabolic response.

With this work, we provide invaluable insights into the molecular pathways involved in lactate-dependent alkalization of niche pH, which is an important factor for virulence and potentially for fungal survival following phagocytosis.

FUNGI AND NUTRITION: EXPRESSION AND SUBCELLULAR LOCALIZATION PATTERNS OF ATO2 TRANSPORT PROTEIN OF *CANDIDA ALBICANS*

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Keywords: Yeast plasma membrane proteins, Candida albicans, Organic Acids

2030 Sustainable Development Goals: SDG3

Candida albicans, a common commensal microorganism within the human body, assumes pathogenic potential in instances of immune system compromise. In 2022, the World Health Organization (WHO) highlighted *C. albicans* as one of the highest concerns, according to the growing health problems, resistance to antifungals, and higher mortality rates associated with this fungus. This opportunistic pathogen can utilize carboxylic acids produced by the host, such as acetate or lactate, particularly in environments with shortage of glucose sources. This metabolic adaptation significantly contributes to the pathogenicity of *C. albicans*.

In *C. albicans*, Jen transporters and potentially Acetate Transporter Ortholog (Ato) proteins are responsible for the uptake of carboxylates through the plasma membrane (PM). The Ato proteins are members of the acetate uptake transporter (AceTr) family comprising 10 proteins, (Ato1 – Ato8) whose role and complete function still remain unknown.

In this study, we aimed at characterizing the expression profiles and subcellular localization of CaAto proteins, particularly CaAto2, in distinct metabolic and physiological conditions. To achieve this aim, we used the CRISPR-Cas9 system to generate a *C. albicans* strain harbouring, at the chromosomal level, an *ATO2-GFP* fusion. Ato2-GFP expression has been evaluated, by fluorescence microscopy, in cells grown in the presence of substrates that are usually present in human host niches, like the gut.

DECODING ALKALI STRESS RESPONSES IN FUNGI

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Keywords: Transporters, Endocytosis, Alkali stress

2030 Sustainable Development Goals: SDG2, SDG5

Saccharomyces cerevisiae yeast cells alkalinize their extracellular environment when cultivated in monocarboxylic acids, as a sole carbon source. This event triggers the removal from the plasma membrane of the nutrient lactate transporter Jen1. The endocytic internalization of Jen1 followed by vacuolar degradation depends on a functional Jen1 transporter and on the involvement of the TORC1 signalling pathway. However, the links between the physiological relevance of this process and the molecular mechanisms underlying it remain unknown.

In this work, *S. cerevisiae* cells stably expressing JEN1-GFP were studied using aerobic carbon limited continuous cultures in controlled bioreactors, followed by a physiological, biochemical and transcriptomic analysis.

Our data showed that Jen1 internalization under alkali-growth conditions is strongly dependent on the external pH, most likely as a mechanism to avoid loss of central carbon metabolites. We have identified by transcriptomic analysis a set of genes that are upregulated at the specific pH value in which Jen1 starts to be internalized.

With this work, we were also able to single out how cells respond specifically to environmental pH, providing new insights on the effect of alkali stress on Jen1 regulation, but also on the general cellular response in eukaryotic cells.

ANALYZING THE ROLE OF KEY AMINO ACID RESIDUES IN *ASPERGILLUS NIGER* DCT-02 ON DICARBOXYLATE TRANSPORT

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Keywords: Carboxylic Acids, Membrane transporters

2030 Sustainable Development Goals: SDG12

DCT-02 is a dicarboxylate transporter from *Aspergillus niger,* member of the Slow-Anion Channel (SLAC1) family. Expression of this transporter in *Saccharomyces cerevisiae* enables succinate secretion, being the divalent succinate anion the preferred transported form. Using a combination of *in silico* tools and phenotypical assays a structural-functional analysis of the exporter was done. The combination of DCT-02's 3D structure prediction, pore outline, molecular docking with succinate and conservation status of amino acid residue in the transporter family led to the selection of 22 residues for site-directed mutagenesis. In total, 32 mutant alleles were functionally characterized by heterologous expression in the *S. cerevisiae* IMK982 strain. Fluorescence microscopy was used to determine the expression and localization of the GFP-tagged version of DCT-02 and mutant alleles. Notably, several of the mutations on residues that were highly conserved resulted in a loss of function for the allele expressing cells, such as is the case for the R114, P204, R255, V274, G275, P276, P354, F353 and N355 mutations, which presented growth similar to *S. cerevisiae* IMK982 strain transformed with the empty vector (p416GPD). With the exception of the mutant allele for the F279, R255, F353 residues and the mutants R114A, R114H and L210A all of the mutant expressing cells showed fluorescence localised in the plasma membrane. One mutant allele when expressed in *Saccharomyces cerevisiae* presents lower growth compared to the wild-type allele expressing strain, which suggests that it is exporting larger amounts of dicarboxylic acids outside the cell. The same phenotype was observed when cells were grown on liquid medium presenting a lower growth rate compared to the wild-type expressing strain. Further studies are underway to characterize succinate production in this mutant. The results here obtained are crucial to understand how exporters work and have the potential for the improvement of microbial cell factories engineered for the production of carboxylic acids.

EXPLORING BENZO[*A*]PHENOXAZINE DERIVATIVES AS ANTIFUNGAL AGENTS AGAINST *CANDIDA*

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Keywords: Benzo[a]phenoxazine derivatives, Candida spp, Antifungals

2030 Sustainable Development Goals: SDG3

Candida species, particularly *C. albicans*, are usually responsible for worrisome infections. The recent rise in non-*albicans Candida* species adds complexity to treatment, given their unpredictable susceptibility to commonly used antifungals. Benzo[*a*]phenoxazines arise as potential therapeutic approaches, due to their established antifungal activity against *S. cerevisiae*. Additionally, through modifications in their polycyclic system, benzo[*a*]phenoxazine derivatives with distinct properties are obtained. C34, with propyl and dipropyl groups at the amino functions of 5- and 9-positions, respectively, demonstrated high antifungal activity against *Candida*, even against the multi-drug resistant *C. auris*. In this work, three compounds with different variations of C34's structure were tested: C35, with chloropropyl group at the amino of 5-position of the heterocycle system; A44 and A42, where the free rotation group at 9-position in C34 and C35 was replaced by a rigid structure conferred by a julolidine moiety.

The antifungal activity of these compounds was evaluated against fourteen strains from seven *Candida* species, determining their Minimum Inhibitory Concentration (MIC), according to the European Committee on Antimicrobial Susceptibility Testing protocols for yeasts. We also tested their cytotoxicity on a macrophage-like cell line, through the MTT assay.

The overall range of MIC values, considering all *Candida* species tested, were very similar between the compounds, except for A42, which displayed the highest MIC values, followed closely by A44, indicating that the addition of the julolidine moiety did not contribute to an enhancement of the anti-*Candida* activity. Compound C34, on the other hand, displayed the best antifungal activity between all four compounds, presenting the lowest MIC geometric mean, followed by C35, making these compounds the most suitable for developing an antifungal strategy. This result indicates that the addition of the chloropropyl group seems to contribute to the anti-*Candida* effect. Cytotoxicity assays showed that C35 and A42 were the least cytotoxic compounds, suggesting that the addition of the chloropropyl group enhances their cytocompatibility. Nevertheless, non-toxic concentrations of all compounds were below *C. albicans* MIC values.

Considering these results, the design of new benzo[*a*]phenoxazine derivatives with potentially improved activity against *Candida* species can be addressed. Compounds C34 and C35 were the most suitable for antifungal applications, considering their synergistic combination with known antifungals, particularly for multi-resistant *Candida* species.

GREEN SYNTHESIS OF PHOTOCATALYTIC NANOPARTICLES FOR THE ELIMINATION OF EMERGING CONTAMINANTS IN WATER

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Keywords: Green synthesis, Photocatalysis, Water remediation

2030 Sustainable Development Goals: SDG6, SDG7, SDG12

Water pollution is one of today's main environmental problems. Emerging pollutants, especially pharmaceuticals, are commonly found in wastewater due to their extensive use in everyday life. Due to their complex chemical structures, they are quite resilient to conventional treatments. Therefore, photocatalysis has emerged as a solution to degrade these contaminants effectively, requiring only a photocatalyst and a source of ultraviolet or visible radiation. Titanium dioxide (TiO_2) is the most studied photocatalyst due to its unique optical and oxidizing properties, chemical and thermal stability, and low toxicity. It is usually functionalised with gold (Au) nanoparticles to prevent electron-hole pair recombination and extend visible radiation absorption. However, conventional synthesis techniques use toxic chemicals and present high energy consumption. In order to decrease the environmental impact, green synthesis methods that utilize natural extracts and ecological solvents have been developed. Therefore, this study proposes a green synthesis procedure that applies a rutin hydrate, a flavonoid found naturally in various plants, as the reducing agent in the green synthesis of TiO_2Au nanocomposites.

Nanocomposites with 1, 0.1, and 0.025 wt% concentrations were synthesised by the co-precipitation method, adding the rutin hydrate to an aqueous solution containing TiO_2 P25 and $HauCl_4$. The chemical and physical properties were studied through characterisation techniques such as TEM, XRD, DLS, ATR-FTIR, zeta potential and reflectance spectroscopy. It was confirmed that the addition of Au nanoparticles onto the surface of TiO_2 nanoparticles via a green method does not alter the morphology and crystalline structure of TiO_2. The band gap and stability were improved, with less agglomerate formation observed.

Afterwards, the nanocomposites' photocatalytic efficiency was tested by degrading the pharmaceutical Ciprofloxacin (CIP) under ultraviolet radiation and simulated sunlight. From a sustainable standpoint, the samples with 0.1 wt% of Au nanoparticles presented the best degradation efficiencies while utilizing the least amount necessary of Au to avoid waste. Approximately 75% of CIP was removed from the water for the degradation under UV radiation, while 73% of CIP was degraded with irradiation by simulated sunlight.

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MULTIFUNCTIONAL FIBROUS STRUCTURES FOR ADVANCED PERSONAL PROTECTIVE EQUIPMENT BASED ON NATURAL FIBRES AND NANOMATERIALS

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Keywords: Personal protective equipment, Natural fibres, Nanomaterials

2030 Sustainable Development Goals: SDG3, SDG12

In the last years, an unprecedented increase in the development of products and technologies to protect the human being has been verified. Now, more than ever, the world population is exposed to several threats, harmful to their well-being and health. Chemical and biological hazardous agents stand out as one of the biggest threats, not only for the military forces, but also for the civilians. Consequently, it's essential to develop personal protective systems that can protect their user, not only passively, but actively, being able to adsorb and decontaminate harmful compounds.

One recent strategy for developing active fibrous structures with improved functions and new properties is their functionalization with nanoparticles (NPs). Although their known effectiveness in the decomposition of harmful agents, NPs could also include other functionalities in the same structure, without adding extra weight. Natural fibres have also emerged as a great material and an excellent alternative to the synthetic ones, due to their high abundance in nature, low cost and biodegradability.

The main goal of this work is the development of multifunctional fibrous structures using the most sustainable processes, taking advantage of the low environmental impact of natural fibres and the great potential of nanomaterials. Natural fibres, like flax and jute, and biopolymers were functionalized with carbon nanomaterials and metal oxide NPs (CaO, MgO, SiO_2, TiO_2 and CeO_2) through different methods. All the developed samples and NPs were characterized by several techniques, such as Attenuated Total Reflectance-Fourier Transform Infrared Spectroscopy (ATR-FTIR), Field Emission Scanning Electron Microscopy (FESEM), Scanning Transmission Electron Microscopy (STEM) and Thermogravimetric analysis (TGA), between others. The multifunctionality of these systems, namely ultraviolet (UV) protection, antibacterial activity, hydrophobicity and electrical properties, as well as their chemical and biological protection capability, including pollutants was evaluated, which demonstrated the great potential of the developed samples for personal protection applications.

LOCAL DRUG DELIVERY SYSTEMS BASED ON BIODEGRADABLE NANOFIBERS FOR CANCER PHOTODYNAMIC THERAPY (PDT)

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Keywords: Cancer photodynamic therapy, drug delivery systems, electrospinning

2030 Sustainable Development Goals: SDG3, SDG12

With an estimated 19.3 million new cases and 10.0 million deaths in 2020, cancer still represents one of the leading causes of death worldwide. Hence, there is an urgent need to explore novel strategies to enhance cancer therapy efficiency and minimize the side effects, improving the patient's life quality. Photodynamic therapy (PDT) is a promising minimally invasive and localized therapy involving the combined effect of photoactive molecules, called photosensitizers (PSs), light, and molecular oxygen, that will destroy the illuminated tissues by the production of reactive oxygen species (ROS). PSs present some drawbacks associated with their systemic administration, that limit their photodynamic effect and the clinical use of several molecules. Thus, localized drug delivery systems (DDS) implanted at the tumor site or close to it have emerged as powerful platforms to decrease the systemic toxicities of drugs, enabling the direct delivery of PSs to the target area, thereby improving the treatment efficacy while decreasing the side effects on the surrounding healthy tissues.

Electrospinning is a very simple, versatile, and scalable technique that allows the production of fibers with controllable diameters ranging from micrometers to nanometers. Recently, electrospun nanofibers have demonstrated great potential to be used as local DDS, because of their large surface area-to-volume ratio associated with high drug loading capacity, controlled porosity, flexibility, resemble extracellular matrix (ECM) structure, and vast possibilities for surface functionalization. Moreover, the adjustment of the membrane's morphology and structure allows the development of controlled release systems, enabling the safe and long-term maintenance of therapeutically effective drug levels.

This work aims to develop a new local DDS for PDT based on biodegradable nanofibers loaded with PSs. These systems will be activated under light irradiation, making this approach more selective to tumor cells, while causing less toxicity to healthy tissues. Several electrospun micro/nanofibers were successfully developed using various biodegradable and biocompatible polymers. Additionally, different fibers' structures (blended and core-shell) were also produced. After the optimization of defect-free micro/nanofibers, the PSs were incorporated (squaraines and porphyrins). All the developed fibrous platforms were fully characterized by various techniques. The release profile of PSs from electrospun membranes was evaluated as well as their cytotoxicity under dark and light conditions against tumor and healthy cells, demonstrating the phototherapeutic potential of these fibrous structures as localized DDS for cancer PDT.

ELECTRIC PROPERTIES OF COTTON FABRICS PREPARED WITH PYROGRAF® III CARBON NANOFIBER-BASED AQUEOUS INKS

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Keywords: Carbon nanofibers, Conductive textiles

2030 Sustainable Development Goals: SDG7, SDG13, SDG17

Here, the production and electric properties of cotton woven fabrics (CWFs) functionalized with aqueous inks made from different amounts of Pyrograf® III carbon nanofibers (CNFs) via dip-coating are presented. At 30 °C, textiles prepared with the highest content of CNFs (6.4 mg ml^{-1}) show conductivities (σ) of ~ 23 S m^{-1}, and Seebeck coefficients (S) of -1 μVK^{-1}, which means that their majority charge carriers are electrons. Above 30 °C (in the interval from 30 °C to 100 °C), the functionalized textiles present a raise of their σ (T) (dσ/dT > 0), and S (T) (dS/dT > 0), respectively. All these results will be presented with the aim of discerning the role of these industrial-grade CNFs on the electric properties of their derived textiles.

SUSTAINABLE AND FUNCTIONAL FASHION DESIGN: A NATURAL DYES APPROACH

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Keywords: Textile and fashion design, Children's clothing, Natural dyes

2030 Sustainable Development Goals: SDG12, SDG13

Colour is a crucial component in the fashion industry, especially in children's clothing. Beyond its aesthetic relevance, colour significantly influences children's cognitive development. However, the interest in textile dyes and clothing items that meet consumer demands often results in the fashion industry exposing harmful consequences to human health and interfering with the conservation of ecosystems.

Moreover, contemporary consumers prioritise hygiene, cleanliness and protection, valuing functional properties that reinforce their well-being. In the context of children's clothing, these concerns are highlighted due to the vulnerability and increased susceptibility to infections and pathologies among this target, particularly children with sensitive skin.

Many natural resources used in colouration have medicinal properties, which are increasingly considered as non-harmful alternatives to conventional products due to their ecological benefits, aesthetic appeal and multifunctional possibilities. However, the prevalence of dangerous auxiliary products to improve dyeing properties remains a concern.

The objective of this study is to provide scientific insights to support the development of sustainable products with both aesthetic and functional qualities for children's fashion brands. These products are intended to attract consumers and promote user well-being through dyeing cellulosic fibres with natural dyes.

The research being conducted uses a mixed methodology, combining quantitative and qualitative methods across different research tasks. The potential expansion of the colour palette is being investigated through the exploration of colours produced by combining the selected dyes and pigments, and mixing them with various auxiliary products. Additionally, the research explores the antibacterial properties and ultraviolet protection inherent in the natural dyes under study.

After conducting a literature review on natural dyes within the primary colour spectrum, three plant dyes were selected for their chromatic properties and potential medicinal benefits: weld (*Reseda luteola)* for yellow, madder (*Rubia tinctorum*) for red, and indigo (*Indigofera tinctoria*) for blue. Preliminary laboratory tests have demonstrated that dyeing processes with indigo plant-derived dye can preserve the antimicrobial properties of the indigo plant in dyed cotton fabrics.

The results achieved will allow for the integration of textile technology with natural resources and their properties, providing a viable path to finding solutions for children's fashion design that offers health benefits and minimizes environmental impact.

DESIGN IN THE FEMININE: KNOWLEDGE, TEXTILE AND FASHION DESIGN

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Keywords: Cultural sustainability, Women textiles, Craft education

2030 Sustainable Development Goals: SDG5, SDG8, SDG10

The textile tradition of northern Portugal, either from an ethnographic and cultural point of view as from the economic and industrial perspective, is mostly associated with female ancestral knowledge. Reflection on female participation in historical, cultural, and economic development represents a transverse necessity to various areas, including design, which can make possible the reproduction of textile handcrafted typologies that are part of the northern region of the cultural lexicon of Portugal. Thus, the research project, as a focus on the development of female textile crafts in northern Portugal, proposes the dialogue between fashion design, cultural sustainability, female textiles knowledge and Portuguese fashion designers. To this end, it is intended to structure methodological teaching strategies involving institutions that have fashion design courses, specifically in the north of Portugal, integrating the interveners: students, designers, teachers, and artisans, to adopt practices of female textile cultural sustainability.

To ensure the development of the project in a reliable way, as well as obtain intellectual and professional contributions, both for the academy and society, the study is supported by the development of the state of the art, through the systematic review of the literature. Then, the study will move on to a field research phase with the objective of mapping, documenting, and analyzing women's textile ancestry in the northern Portugal. At this stage, the investigator will resort to the methods of collecting images, videos and interviews with artisans and regional entities. It will also be part of this moment the research on the role of women in the northern textile cultural process of Portugal and the relationship between Portuguese fashion designers. By academic and reflective nature, the project will be conducted through anthropological and design methodologies, Design-Based Research, that will provide the necessary guides for the elaboration and application of the other methods and methodologies cited, especially because its investigative character is associated with new teaching approaches to the design and in the very experimental nature of the discipline. Thus, it will be possible to guarantee the constant convergence between fashion design and female textile crafts, as well as guiding the research based on the social and academic trends necessary for the methodological construction that is proposed in this dialogue.

Finally, it is intended to develop teaching, academic and cultural materials that contribute to the dissemination of female textile interactions of northern Portugal, cultural sustainability through fashion design and reflection on the identity of Portuguese fashion design.

STRATEGIES TO ENHANCE ECOLOGICAL COLORATION IN FASHION DESIGN: SUSTAINABLE COLOR

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Keywords: Fashion and textile designers, Active training, Sustainable fashion.

2030 Sustainable Development Goals: SDG4, SDG6, SDG8

The integration of sustainability and circularity principles into textile products is centered on the design process. Some studies show that up to 80% of a product's environmental impact is determined in the design process. The designer and the team responsible for product development must be prepared and updated to reflect on the decisions made during the design stage, regarding the choice of materials, colors, finishes, accessories, modeling, and packaging.

There is a growing demand for aware, stimulated, qualified, and aware professionals to deal with issues related to sustainable development. To meet this urgent need, this research aims to contribute through the development of practical training and a sustainable color guide, to enhance the adoption of ecological coloration practices in fashion and/or textile design. This study was limited to the topic of textile coloration, mainly because it is one of the processes in the textile chain with the greatest environmental impact, the dynamism involved in the various stages and different chemical products, which in general becomes a complex topic for designers. Furthermore, there is a need to clarify the concepts of materials and emerging technologies for sustainable coloration.

Initially, a literature review was carried out to identify ecological/low environmental impact coloration processes and colorants, and emerging technologies. Given the theoretical basis constructed, interviews were carried out with two groups of professionals. The first group with 11 expert designers to understand the challenges during the design process and perspectives on the sustainable coloration processes. The second group, with 10 active professionals in the Textile Industry in Portugal, to identify the offers and perspectives of sustainable textile coloration. The results obtained from data collection indicated the topics with the greatest need for training and generated insights for structuring the program content of training activities and the development of auxiliary teaching tools.

The training activities were carried out in a laboratory environment, with students from the fashion design and marketing graduate at the University of Minho and professionals from the Portuguese Textile Industry. The results of these workshops validated the teaching tools developed and reaffirmed the interest of students and active professionals in developing up-to-date knowledge about the coloration process. Furthermore, it demonstrates that using practical training to develop new skills and critical thinking related to sustainability in the textile and fashion industry is an efficient strategy.

SMART PRINTED TEXTILE DESIGN AND THE CREATION OF SYMBOLIC VALUE THROUGH EMOTIONAL EXPERIENCE

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Keywords: Smart and Interactive Textiles, User Experience, Cultural Sustainability

2030 Sustainable Development Goals: SDG8, SDG9, SDG12

The increase in research and development of textiles innovations has been fundamental for improving technologies in smart wearables market. This is expected to gain popularity in 2030 and worth more than US$4 billion. Smart textiles refer to textile artifacts that interact – reacting or adapting – with environmental changes, extending or providing functionality to common fabrics. Despite the advantages, the popularization of these technologies still depends on overcoming challenges, particularly related to usability. The interface design of these products presents itself as a notable strategy to innovate. Among the processes of incorporating technologies on the textile surface, printing is one of the means that offers great integration potential.

In addition to functional and pragmatic issues, design must also consider the emotional dimension, therefore it is relevant to understand the affective responses objects provide. Since it influences the user psychological conditions, hedonic approach has been increasingly contemplated in smart textiles and wearable technology field.

Symbolic value is approached here as a conceptual focus to evaluate experience at an emotional level and as a relevant path towards cultural sustainability – one of the priority themes of United Nations Educational, Scientific and Cultural Organization (UNESCO). In this aspect, it is understood that awareness and information related to memory and cultural heritage can be accessed through printed patterns. In parallel, perceived symbolic value should encourage a longer product lifespan, due to the meaning it carries and the relationships it represents with the user, thus also contributing to environmental sustainability.

In the field of usability in printed smart textiles for applications in technical areas, several studies have been carried out. However, the specificity of the intersection between the areas of printed smart textiles (not only as functional but as holders of aesthetic, symbolic and cultural values) and user experience (UX), an intrinsic concern of the disciplinary area of Design, still lacks investigations with great potential to be developed, which this project proposes.

This research aims to explore printing design for smart and interactive textiles – namely with colour change behaviour –, as a means of incorporating symbolic and emotional values from the UX perspective.

The scientific contribution is expected to be the expansion of knowledge in these areas, which currently lacks intersectional in-depth study.

EDUCATION FOR CIRCULAR ECONOMY: CONTRIBUTIONS TO THE DEVELOPMENT OF INNOVATIVE TEACHING-LEARNING METHODOLOGIES AND STRATEGIES

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Keywords: Circular Economy, Education, Fashion Design

2030 Sustainable Development Goals: SDG12, SDG13

The fashion industry positions itself as one of the most important and dynamic sectors globally, however, it is also one of the most polluting. The excessive production of fashion items makes it a significant consumer of natural resources and a major producer of waste throughout its value chain.

It becomes imperative to take action to change the course of the enormous impact it has on the environment, not only through public policies affecting the industry but also through government or public initiatives that raise awareness among the population about the excessive impact of human activity. Circular economy (CE) emerges as an alternative to the prevailing model (Fast Fashion), characterized by extraction, manufacturing, use, and disposal, serving as a guide for the fashion industry, promoting the development of more sustainable products, and encouraging the reuse and recycling of products and raw materials. In this model, the concept of waste, much like in nature, does not exist, as everything is perceived as a resource.

For the transition from a "cradle to grave" model to a "cradle to cradle" model (Braungart and McDonough) to be solidified, consumers of fashion items will also need to change their purchasing behaviours. The bidirectional relationship between supply and demand is crucial for the successful implementation of the CE in the fashion industry. Therefore, it is imperative that consumers have a proper understanding of their importance in this process, with education playing a significant role in raising awareness among the youth. Education for sustainability aims to broaden the horizons of young people regarding this issue and the role they play with the choices they make in their daily lives.

In a general sense, the presented research ultimately aims to develop innovative teaching-learning methodologies and strategies for the CE, to be implemented with high school students. These methodologies and strategies will draw inspiration not only from what is already being developed in the context of formal education for this level, specifically in the Fashion Design Technical Course, but also from national and international initiatives focusing on fashion and sustainability, as well as in design methods and techniques in fashion design.

Methodologically, the research employs mixed methods, both interventionist and non-interventionist, and qualitative and quantitative techniques to address the research question and confirm the research argument based on the premise that the activities developed and implemented in the classroom will reinforce future sustainable behaviours and interventions among young people.

CENTRO DE ENGENHARIA BIOLÓGICA

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MICROBIAL LIPIDS PRODUCTION BY *YARROWIA LIPOLYTICA* STRAINS FROM LIGNOCELLULOSIC BIOMASS HYDROLYSATES

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Keywords: Lignocellulosic biomass hydrolysates, Microbial lipids, Yarrowia lipolytica

2030 Sustainable Development Goals: SDG7, SDG13

In recent years, energy crises and environmental concerns with fossil fuels have driven research into alternative lipidic sources to traditional vegetable oils for the biofuels industry. Microbial lipid production from lignocellulosic biomass (LB) emerges as a promising raw material for the biodiesel production. The recalcitrant structure of LB requires pretreatments to release monomeric assimilable sugars for microbial species. However, these pretreatments generate some undesired compounds with antimicrobial activity.

This research aims to assess the potential of *Y. lipolytica* strains to use lignocellulosic biomass hydrolysates (LBH) without detoxification steps for lipid-rich biomass production. Firstly, the tolerance of three *Y. lipolytica* strains to undesired compounds (acetic acid, formic acid, furfural, and 5-HMF) was assessed in microplate wells. The production of lipid-rich biomass of chosen strains (W29 and NCYC 2904) was validated in stirred-tank bioreactor (STR) using synthetic medium mimicking an LBH. In batch cultures, the W29 strain attained the lipids content and concentration of 29 % (w/w, dry basis) and 4.7 g/L, respectively, while the NCYC 2904 strain reached 53 % (w/w) and 10.9 g/L. In the repeated batch cultures, the lipids produced by the W29 strain increased to 6.6 g/L, while with the NCYC 2904 strain the lipids production attained 13.9 g/L.

The ability of W29 strain to grow and produce lipids was proven in eucalyptus bark hydrolysate (EBH) in STR experiments. Regardless of the total sugars (65 g/L or 106 g/L) and antimicrobial compounds concentration of EBH, the yeast successfully grew in undiluted and undetoxified EBH. The maximum lipids concentration increased from 5.6 g/L (65 g/L of total sugars) to 8.1 g/L (106 g/L of total sugars) due to the high biomass production in more concentrated EBH. *Yarrowia lipolytica* NCYC 2904, grown in undiluted and undetoxified olive tree pruning hydrolysate (129 g/L of total sugars), accumulated 35 % (w/w) of lipids, corresponding to a concentration of 10 g/L. Lipids from both strains were highly unsaturated, mainly composed of oleic acid, indicating their suitability as feedstock for the biodiesel industry.

This research highlights the extraordinary ability of both *Y. lipolytica* strains in utilizing LBH for microbial lipids production, thereby promoting sustainable biodiesel production from lignocellulosic feedstocks. This approach not only reduces process costs but also minimizes resource wastage, aligning with the principles of a circular economy. Furthermore, it aligns with the objectives of The European Green Deal, promoting the transition from fossil fuels to biofuels and contributing to the reduction of global gas emissions.

EXPLORING *YARROWIA LIPOLYTICA* STRAINS FOR BIOCONVERSION OF HYDROCARBONS INTO HIGH-VALUE COMPOUNDS

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Keywords: Hydrocarbons, Yarrowia lipolytica, Microbial lipids

2030 Sustainable Development Goals: SDG7, SDG12, SDG13

Economic activities are strongly dependent on the use of fossil fuels and petroleum-derived products. Hence, huge amounts of hydrocarbon-polluted wastewater are produced in several industries (petrochemical industries, automotive and automobile repair stations, etc.). The improper disposal of this wastewater presents a substantial environmental challenge. Microbial degradation of hydrocarbons offers an alternative to the physicochemical methods commonly employed and several works have been reported mainly with bacterial species.

This research evaluated the potential of using a yeast, *Yarrowia lipolytica,* to assimilate hydrocarbons and produce valuable compounds. This oleaginous yeast *species* has an intense secretory activity and demonstrates an extraordinary capacity to use a wide range of hydrophobic compounds, including non-refined ones.

Firstly, six *Y. lipolytica* strains were studied for their ability to assimilate 5 $g \cdot L^{-1}$ hexadecane as the sole carbon source. *Y. lipolytica* CBS 2075 stood out as the most promising in hexadecane consumption and biomass production, and further experiments were carried out in a stirred-tank bioreactor (STR) to evaluate the effect of the volumetric oxygen transfer coefficient (k_La). Increasing k_La from 11 h^{-1} to 132 h^{-1} improved the hexadecane assimilation rate, biomass final concentration, and lipids synthesis. The supplementation of medium with corn steep liquor, a low amount of $(NH_4)_2SO_4$, and an increase in the C/N ratio boosted the production of microbial lipids (2.1 $g \cdot L^{-1}$) and protease (526 $U \cdot L^{-1}$).

The yeast *Y. lipolytica* also demonstrated efficient assimilation of a hydrocarbon mixture (2 $g \cdot L^{-1}$ dodecane, 2 $g \cdot L^{-1}$ hexadecane, and 2 $g \cdot L^{-1}$ hexadecene). In batch cultures, two *Y. lipolytica* strains grew without a lag phase, and dissolved oxygen saturation of 30 % was enough to prevent the limitation of lipids and protease production. Additionally, the strategy of stepwise batch cultures with 3 pulses of hydrocarbon mixture (24 $g \cdot L^{-1}$ of hydrocarbons in total) enhanced biomass production, and high protease activities (≈ 3000 $U \cdot L^{-1}$) and lipids concentrations of 3.4 $g \cdot L^{-1}$ and 4.3 $g \cdot L^{-1}$ were attained using *Y. lipolytica* CBS 2075 and DSM 8218strains, respectively. Lipids of the CBS 2075 strain were rich in C16:0 and C18:1, resembling the composition of palm oil, traditionally used in the biodiesel industry. Lipids from the DSM 8218 strain were mainly composed of C16:0 and C16:1, a valuable monounsaturated fatty acid employed in the pharmaceutical industry.

This research demonstrates the capability of *Y. lipolytica* to bioconvert hydrocarbons into high-value compounds, aligning with the principles of biorefinery and circular bioeconomy.

VALORIZATION OF RED, GREEN AND BROWN SEAWEEDS THROUGH SOLID-STATE FERMENTATION TO IMPROVE ITS NUTRITIONAL VALUE

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Keywords: Seaweeds, Solid-state fermentation, Carbohydrases

2030 Sustainable Development Goals: SDG2, SDG12, SDG14

Seaweeds are promising ingredients for aquafeeds, but its use may be limited due to their recalcitrant polysaccharide structure. To disrupt this structure, a biotechnological approach such as solid-state fermentation (SSF) can be applied, using filamentous fungi to produce carbohydrases (xylanase, cellulase, and β-glucosidase) that degrade seaweeds biomass.

In this study, the proximate composition of five seaweeds (*Gracilaria* sp., *Porphyra dioica*, *Codium tomentosum*, *Ulva rigida* and *Alaria esculenta*) were evaluated. SSF was performed using *Aspergillus ibericus* MUM 03.49 and *A. niger* CECT 2915 with 5 g of each dry seaweed, with initial moisture of 75% w/w (wet basis), at 25 ºC for 7 days. After SSF, crude protein and carbohydrate contents were determined in fermented solid, and an aqueous extraction was performed to assess carbohydrases activity.

Red seaweeds had the highest protein content, specially *Gracilaria* sp. (28 % w/w dry solid) followed by *P. dioca* (24 % w/w). Comparing to the other seaweeds, *C. tomentosum* presented the highest lipids content of 6 % (w/w).

Maximum xylanase and β-glucosidase activities were obtained using *U. rigida* as substrate for SSF with both fungi. Cellulase activity was higher in SSF of *Gracilaria* sp. and *U. rigida* with *A. niger* than when using the other seaweeds. Protein content increased by SSF of *C. tomentosum* with *A. ibericus* and by SSF of *U. rigida* with A. *ibericus* and *A. niger*. Carbohydrate content decreased after SSF of *U. rigida* using both fungi.

Furthermore, *Gelidium corneum* by-product (GBP) obtained after agar extraction was also used for value-added compound production through SSF with the same fungal strains. GBP was used as substrate for SSF unsupplemented, supplemented with Mandel salt solution, and in a 50% (w/w) mixture of GBP with vegetable cakes by-products and *U. rigida*. The changes in crude protein and carbohydrases production in the fermented biomass were assessed. The maximum xylanase activity of around 500 Units per gram of dry solid (U g^{-1}) was achieved with SSF of GBP mixed with sunflower cake using *A. niger*, while the mixture between GBP and rapeseed cake led to the highest cellulase activity (382 U g^{-1}). Protein content increased 30%, 18% and 15% after SSF with *A. niger* in GBP mixed with rice bran, rapeseed, and sunflower cakes, respectively.

Bioprocessing of seaweeds or seaweed by-product using SSF is an environmentally friendly strategy to produce high-valued enzymes simultaneously enhancing nutritionally these biomasses to be included in aquafeeds.

THE HIDDEN POTENTIAL OF HYPERSALINE ENVIRONMENTS: EXTREMOPHILES AS SOURCE OF NEW BIOSURFACTANTS

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Keywords: Metagenomics, Biosurfactants, Hypersaline environments

2030 Sustainable Development Goals: SDG12, SDG13, SDG17

The current awareness on climate change is prompting a growing interest in finding sustainable alternatives to replace the petroleum-based surfactants that are widely used in the daily life products. Biosurfactants emerge as eco-friendly alternatives to the conventional surfactants, since they are surface-active molecules synthesized by microorganisms with lower environmental impact. These molecules have application in several fields including cosmetics, pharmaceutical, detergents, food, and textile industries. Lack of well-known and characterised structure diversity associated with their high production and recovery costs are impacting the widespread use of biosurfactants. Extreme environments like those found in hypersaline sites are a good source of unique microbial diversity (extremophiles) capable of produce new compounds, including biosurfactants. In this context, the B3iS – "Biodiversity and Bioprospection of Biosurfactants In Saline environments" project aims to uncover new biosurfactants from hypersaline environments that can be promising eco-friendly alternatives to the conventional surfactants, to ultimately mitigate their environmental burden.

For that purpose, culture-dependent and culture-independent (metagenomics) strategies were applied to explore the full microbial diversity of four selected environments: Aveiro and Rio Maior salterns (Portugal), Peña Hueca lagoon (Spain) and Cape Verde salterns (Sal Island). In the culture-dependent approach several halophilic microorganisms were isolated, screened for biosurfactant production and their genomes sequenced for functional analysis and identification of potential biosurfactant biosynthetic pathways. On the other hand, in the culture-independent approach, the total genomic DNA from the microbial communities of each selected environments was extracted and used to construct metagenomics libraries that were functionally screened to identify potential biosurfactant-producing clones. The physicochemical analysis revealed an interesting diversity in terms of salinity, pH, and ionic content for the different sampling sites. The strategies carried out allowed the identification of novel microorganisms and metagenomic clones with potential to produce promising biosurfactants. The sequence metagenomics approach also showed an enrichment in genes coding for biosurfactants with specific categories appearing only in some locations. This information was obtained by mapping the isolated metagenomes against the BioSurfDB database. Overall, the results corroborate the relevance of the B3iS project in identifying novel biosurfactants with attractive industrial properties by mining hypersaline environments.

ASSESSMENT OF THE POTENTIAL OF NATURAL MICROBIOMES FOR MICROPLASTICS BIODEGRADATION: A COMPARATIVE STUDY OF POLY(E-CAPROLACTONE), POLYETHYLENE AND POLYETHYLENE TEREPHTHALATE

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Keywords: Microplastics, Biodegradation, Microbiomes

2030 Sustainable Development Goals: SDG3, SDG6, SDG14

Plastics have evolved into an essential component of modern society, assuming important roles across diverse economic sectors. Consequently, plastic waste accumulation has become a serious environmental problem, impacting both wildlife and human health. Microbial degradation of both synthetic and biodegradable plastics is a promising environmentally friendly approach to tackle this issue.

This study delves into the capacity of natural microbiomes, found in landfill leachate and marine sediment, to biodegrade microparticles of polyethylene (PE), polyethylene terephthalate (PET), and polycaprolactone (PCL). Microcosms were inoculated with the two microbiomes, and the assays were performed under aerobic and anaerobic conditions, at thermophilic (55 °C) and mesophilic (37 °C) temperatures. Plastics biodegradation was followed overtime by measuring oxygen consumption or methane production.

PCL was extensively biodegraded by the landfill leachate, reaching 99±7% and 87±19% under aerobic and anaerobic conditions, respectively, within 50-60 days. This polymer was also biodegraded by the marine sediment under aerobic conditions (i.e., 78±3%) within the same time period, but only 3±0.3% biodegradation was attained in the anaerobic assays. Limited biodegradation was verified for PE and PET with both inocula.

Given the PCL biodegradation capability of landfill leachate, microbial communities in both anaerobic and aerobic assays were investigated. *Coprothermobacter* sp. emerged as a prevalent microorganism, representing 6.8% and 28% of relative abundance (based on 16S rRNA sequencing of total microbial community) in anaerobic and aerobic incubations, respectively. This shows its potential role in PCL biodegradation across diverse conditions. Additionally, *Methanothermobacter* sp. emerged as the predominant methanogenic microorganism in the anaerobic community, (21% of total microbial community). Since bacteria from *Coprothermobacter* genus are capable of hydrogen production, and *Methanothermobacter* is a hydrogen scavenger, syntrophic interactions are possibly occurring, which is a novel aspect in microplastics biodegradation. In the aerobic community, fungi from *Exophiala* (41% 18S rRNA relative abundance), *Penicillium* (17%), and *Mucor* (18%) genera were also abundant, suggesting a possible role in PCL degradation. Consequently, aerobic PCL biodegradation by landfill leachate likely involves a synergistic network of fungi and bacteria, either operating independently or interacting within a complex microbial matrix.

These findings advance current knowledge on microplastics biodegradation. The insights derived from this study may pave the way for the development of more sustainable approaches to plastic waste management, emphasizing the crucial consideration of specific environmental conditions and microbial interplays in biodegradation studies.

DEVELOPMENT OF FOAM-FREE BIOSURFACTANT PRODUCTION PROCESSES USING *BACILLUS LICHENIFORMIS* STRAINS

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Keywords: Lichenysin, Lipopeptide, Surfactant.

2030 Sustainable Development Goals: SDG6, SDG9, SDG12, SDG13

Microbial biosurfactants (BS) are considered environmentally friendly alternatives to synthetic surfactants in numerous applications. However, the main bottlenecks for their widespread use are the high production costs and the lack of effective processes for their production at industrial scale. BS production using conventional aerated bioreactors results in excessive foaming, due to the combination of air injection and the tensioactive properties of BS. Although several alternatives have been proposed to overcome this problem, none of them proved to be satisfactory. A not widely explored approach is the development of foam-free BS production processes, which requires the identification and characterization of appropriate microorganisms. For that purpose, eight *Bacillus licheniformis* strains were evaluated for BS production under oxygen-limiting conditions. The bacterial strains were grown in serum flasks using a mineral medium (MSM1) containing glucose as carbon source, and $NaNO_3$ and NH_4Cl as nitrogen sources (nitrate was used also as alternative electron acceptor). Among the different strains, only two reduced the surface tension (ST) of the culture medium to values below 30 mN/m, indicating BS production under oxygen-limited conditions. The best results were obtained with *B. licheniformis* EL3, isolated from an oil reservoir, which reduced the ST from 59.8 ± 0.8 mN/m to 29.3 ± 0.3 mN/m in 24 h. BS production under oxygen-limiting conditions by the strain EL3 was validated in bioreactor assays, using the culture medium MSM1. After optimizing the operational conditions, glucose concentration, and inoculum strategy, *B. licheniformis* EL3 produced 75 ± 3 mg BS/L in 43 h. The purified BS (most probably the lipopeptide lichenysin) exhibited exceptional surface-active properties, with minimum ST values (29 mN/m) and a critical micelle concentration (27 mg/L) similar to those achieved with commercial surfactin (produced by *Bacillus subtilis*), the most powerful BS known so far. Furthermore, BS yield per substrate ($Y_{P/S}$= 0.007 g BS/g glucose) was similar to the figures reported for *B. subtilis* strains grown in similar conditions, whereas BS yield per biomass ($Y_{P/X}$= 0.755 g BS/g biomass) and specific BS productivity (q_{BS}= 0.018 g BS/(g biomass × h)) were almost three times higher when compared to previous reports. In summary, the results obtained indicate that *B. licheniformis* EL3 is a promising candidate for the development of foam-free BS production processes at industrial scale.

UNCOVERING NOVEL CARBOHYDRATE-DEGRADING ENZYMES FROM COMPOSTING UNITS THROUGH METAGENOMIC STRATEGIES

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Keywords: Metagenomics, Composting, Carbohydrate-degrading enzymes

2030 Sustainable Development Goals: SDG9, SDG12

The vast diversity of unexplored microbial communities inhabiting the extreme environments of our planet drives the search for novel and interesting enzymes. Composting units that manage lignocellulosic residues exhibit a high microbial diversity and represent a suitable reservoir of robust carbohydrate-degrading enzymes (CAZymes). These enzymes are considered important catalysts in the bioconversion of lignocellulosic biomass into added-value bioproducts that hold practical applications in numerous industries.

Metagenomics is a powerful culture-independent technique to unravel the diversity and function of microbial communities through the analysis of DNA obtained from environmental samples. Two different methodologies have been proposed, namely function- and sequence-based metagenomics. The functional approach enables the discovery of novel enzymes and provides preliminary insights into their catalytic activities and physicochemical characteristics. On the other hand, the sequence-based studies allow finding new gene sequences that reveal similarities with the annotated genomes available in the databases.

Under the scope of the Lignozymes project, compost samples were collected, during the thermophilic phase of the process, from different Portuguese composting units, which handle different types of waste. The total metagenomic DNA was extracted and the potential of composting samples as reservoirs of efficient CAZymes was successfully evaluated using metagenomic tools. Regarding the taxonomic classification of the putative enzymes found in the samples' metagenomes, CAZymes largely belonged to the Bacteria domain. Furthermore, functional screening revealed that the composting samples showed a great abundance of glycoside hydrolases, particularly cellulases and xylanases. This work confirms the richness of composting habitats as a promising source of biocatalysts specialized in the degradation of lignocellulosic biomass through efficient and sustainable strategies.

INNOVATIVE INTEGRATION OF OILFIELD PRODUCED WATER TREATMENT WITH BIOGAS PRODUCTION FOR SUSTAINABLE RESOURCE MANAGEMENT

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Keywords: Alcanivorax borkumensis, Wastewater valorization, Biogas

2030 Sustainable Development Goals: SDG6, SDG7

Oil and gas extraction activities generate wastewaters with a large content in aliphatic hydrocarbons, in the form of produced water (PW). The use of aerobic biological treatment methods allows the removal of dissolved hydrocarbons that are often not eliminated by other methods and opens the possibility to value PW, converting it from a waste product to a low-cost feedstock. Specifically, the marine bacterium *Alcanivorax borkumensis* proves advantageous for such treatments, efficiently converting hydrocarbons in saline environments to storage lipids. Lipids are known as ideal candidates for biogas production through anaerobic digestion (AD), yielding more methane (CH_4) than other macromolecules. Following this, the present study explores the possibility to value PW by generating biogas using the lipid-rich effluent from the treatment with *A. borkumensis*, or alternatively, the separated lipid-rich biomass.

Biochemical methane potential (BMP) assays were conducted using as substrate whole effluent (Eff) or lyophilized biomass (LfB) collected from a sequencing batch airlift reactor inoculated with *A. borkumensis* SK2 (DSM 11573) treating PW. BMP assays with LfB (2 g COD/L) were performed using disrupted anaerobic granular sludge as inoculum (7 g VS/L). In BMP assays with Eff (0.6 g COD/L), a mix of suspended and granular anaerobic sludge previously adapted to salinity was used (11 g VS/L). Both assays were incubated at 37 °C, 90 rpm and CH_4 was measured by GC-FID.

The BMP assays of LfB demonstrated its potential as substrate for AD, achieving a CH_4 production of 109 ± 17 L CH_4/ kg COD, which corresponds to a conversion of 31 ± 5 % of the added COD to CH_4. However, the presence of salts from LfB likely inhibited to some extent the methanogenic activity. On the other hand, the BMP assays of Eff exhibited the benefit of pre-adapting the anaerobic inoculum to salinity to overcome potential inhibitory effects. In these assays were produced 184 ± 37 L CH_4/ kg COD, corresponding to a conversion of 53 ± 11 %.

In summary, both collected biomass and the entire effluent from the aerobic treatment of PW with *A. borkumensis* exhibit the potential to efficiently generate biogas through AD, due to their lipid-rich content. Since the direct AD of hydrocarbons is a very slow process, this integrated approach combining aerobic treatment methods with AD intends to accelerate the bioconversion of hydrocarbons to biogas and increase yields by using bacterial storage lipids as intermediaries.

COBALT AND MANGANESE SPECIATION IN ANAEROBIC SLUDGE TREATING PTA PRODUCTION WASTEWATER

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Keywords: Metal speciation, Metal supplementation, Metal requirements.

2030 Sustainable Development Goals: SDG6, SDG12

Purified terephthalic acid (PTA) is a key raw material in petrochemical industry, widely utilized in products, like PET bottles and polyester fiber. In PTA manufacturing, metals Co and Mn are employed as catalysts, generating PTA/metals-contained wastewater. In anaerobic digestion (AD) process treating this wastewater, metals are retained in the granular sludge bed, forming a metal pool that either sustains the microbial population's trace metal requirements or, when in high concentrations, induces microbial toxicity. The total metal content in the sludge is not a reliable indicator of metal bioavailability or toxicity. Instead, understanding the metal speciation in the sludge is crucial to determine the dynamics of retention versus leaching, and balancing the AD process through proper metals supplementation.

More than improving the AD process, the environmental impact of circular economy strategies must be considered, targeting to enhance treatment techniques that recover and recycle materials from waste. Co recovery studies are particularly important due to its toxicity when discharged improperly, high economic value, and industrial applications. This study aimed to evaluate Co and Mn speciation in anaerobic granular sludge (AGS), using a sequential extraction procedure (SEP). This strategy would help to understand their bioavailability and to control the need of their supplementation in the AD process. The SEP gives some insights into metal bioavailability (from highest to lowest) according to its phase bound in the sludge: exchangeable (EXG), carbonate (CARB), bound to organic matter/sulfide (OM/S), and residual (RES).

To test the bioavailability of the metals in the AGS two bioreactors, R212 and R222, were operated. During 75 and 120 days, PTA wastewater was continuously fed into the reactors as the organic carbon source, with the addition of macro and micronutrients (i.e., Mg, P, N, K, Cu, Zn, Ni, Mo, Se, and Al). Both reactors were operated without addition of Co and Mn and showed no signs of system stress during the testing period. Co remaining in OM/S fraction with contents above 94 % and 98 %, for R212 and R222, respectively. Mn was found in CARB and OM/S fractions in R212, and distributed between EXG, CARB and OM/S fractions in R222, showing the highest bioavailability. The results showed that the supply of Co and Mn in the AD process of PTA production wastewater can be obtained from the wastewater and sludge without any extra addition. Thus, this strategy of Co evaluation proves that the external Co addition is unnecessary, which leads to a more cost-effective and environmentally sustainable AD system, contributing to a green circular economy.

CENTRO DE FÍSICA DA UNIVERSIDADE DO MINHO E DO PORTO

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CF-UM-UP

PASSIVE SAMPLING FOR AIR QUALITY ASSESSMENT: COLLABORATION BETWEEN CCDR-N AND UNIVERSITY OF MINHO

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Keywords: Air pollution, Nitrogen oxides (NOx), Passive sampling

2030 Sustainable Development Goals: SDG3, SDG11, SDG13, SDG17

Air pollution in urban areas has become a primary global concern, leading to problems on different scales, for example, human health related to cardiorespiratory issues, contribution to climate change (intensification of the greenhouse effect), and acid rain formation, among others. This issue is exacerbated in large cities due to the high concentration of pollutant-emitting vehicles. World Health Organization (WHO) asserts that air pollution poses the most significant risk to environmental health, estimating that 92% of the global population resides in areas where pollution exceeds safety limits. An analysis released by the United Nations reveals that one-third of the world's countries lack ambient air quality standards mandated by law. Furthermore, at least 31% of nations capable of adopting such standards have yet to do so.

Thus, it is essential to monitor, control and act on the air quality. Currently, there is a cooperation protocol between the University of Minho and the Northern Regional Coordination and Development Commission (CCDR-N) aimed at fostering the development of more sustainable and cost-effective solutions with the capacity to monitor air quality.

In this context, the passive sampling method is being evaluated to calculate the NO_x levels present in the air over a specific period. This approach is a low-cost, non-electrical, and simplified solution for the distribution of samples. The principle of the passive sampler involves gas collection through the diffusion of atmospheric air, which enters the device through one of its ends, travels through the body of the sampler (in the form of a tube) until it reaches its other end, which is sealed and contains a filter paper previously impregnated with a specific absorbent solution designed to react with the targeted pollutant to be collected. This innovative approach not only enhances the capabilities of environmental monitoring but also contributes to the advancement of more effective and economical solutions for air quality assessment.

DEVELOPMENT OF CORE-SHEATH PHASE CHANGE FIBRES INCORPORATED WITH PEG2000 FOR THERMOREGULATION APPLICATION

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Keywords: Urban Heat Island; Core-Shell Fibres; Thermal regulation

2030 Sustainable Development Goals: SDG9, SDG11, SDG12

The resilience of urban infrastructures in the face of climate challenges has become a public concern, with direct impacts on the well-being of citizens due to frequent environmental, economic and social influences. Asphalt pavements, widely present in urban centres, contribute negatively to the Urban Heat Islands (UHI) effect, which is responsible for slowly absorbing and releasing heat due to their dark surfaces.

The incorporation of phase change materials (PCM) into these asphalt mixtures, as highlighted in the literature, has emerged as an effective solution to improve thermoregulation with the aim of mitigating problems associated with UHI. This topic is directly related to the objectives SDG9, SDG11, and SDG12 of the United Nations (UN), associated with resilient and sustainable cities, and represents a considerable challenge that must be addressed.

Therefore, this research aims to evaluate the ideal composition of PCFs comprising a cellulose acetate sheath (CA, Mn 30,000 and 50,000) and a polyethene glycol (PEG) 2000 core as PCM, produced by the wet spinning method. The presence and influence of PEG 2000 inside PCFs were investigated morphologically, chemically and thermally using bright-field microscopy, attenuated total reflection Fourier transform infrared spectroscopy (ATR-FTIR), thermogravimetric analysis (TGA) and differential scanning calorimetry (DSC), respectively.

Using a bright-field microscope, it was possible to observe the difference between the sheath and the core of the PCFs and revealed that the morphologies of the PCFs depend on the ejection speed of PEG 2000. TGA confirmed the capability of PCFs to resist high temperatures. DSC confirmed the phase change of PEG 2000, as its peaks with melting points were close to those of virgin PEG 2000, with a slight change caused by the protective CA sheath. Therefore, the results revealed a successful Production of PCFs through wet spinning confirming the compatibility of the phase change temperature of PEG 2000 with the application to infrastructures subjected to moderate temperature between 50-60 °C.

UNDERSTANDING THE INFLUENCE OF MECHANO-ELECTRICAL STIMULI FOR NEW NEURONAL REGENERATION THERAPIES

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Keywords: Tissue engineering, Astrocytes, Piezoelectric materials

2030 Sustainable Development Goals: SDG3

Current therapies for diseases related to the nervous system have numerous limitations, leading to inefficient and transient outcomes. Tissue engineering is a technique that can help address this impasse. Neuronal tissue engineering has demonstrated its potential in promoting nerve cell regeneration and proliferation. In this regard, piezoelectric materials have proven to be useful, allowing for cell stimulation in a localized and minimally invasive manner.

In this study, poled and non-poled poly(vinylidene fluoride) (PVDF) films were utilized, as well PVDF fibers with different orientations. All these materials underwent morphological (SEM, AFM), physiochemical (FTIR), and mechanical characterization. The impact of these materials on the behaviour of astrocytes cells, crucial for the proper functioning and support of the nervous system, was also evaluated through cell proliferation assays under static and dynamic conditions.

Morphological analyses showed that fibers were thicker than films, with no significant difference in diameter between oriented and non-oriented fibers. Physicochemical evaluation revealed a higher β-phase fraction in fibers, reaching 90%, compared to films. Mechanical analyses demonstrated that PVDF films had a higher Young's modulus compared to the fibers, and the modulus varied with fiber orientation, being higher in oriented ones.

Furthermore, cellular assays indicated that astrocytes responded well to PVDF regardless of morphology, with the best results obtained in oriented fibers. Regarding the surface charge of the films, positively charged films appeared to enhance astrocyte growth. Additionally, mechanical stimuli promoted astrocyte proliferation in all samples. It’s noteworthy that the impact of poly-d-lysine was ambiguous; while it decreased astrocyte proliferation in films, it had the opposite effect in fibers.

In conclusion, our study confirms that the developed materials and the associated stimuli can influence astrocyte proliferation, presenting a new possibility for neuronal tissue engineering strategies.

STRATEGY TO SAFEGUARD CORK AND RUBBER APPLICATION'S BEAUTY AND LONGEVITY: SUSTAINABLE THIN FILM DEPOSITION

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Keywords: Cork and rubber, Magnetron sputtering, TiO_2 and ZnO thin films

Optimizing materials' performance while preserving essential bulk characteristics often involves surface modification through thin film deposition. However, when dealing with delicate or intricate substrates, this process becomes more challenging. Take, for example, cork and rubber—natural, polymeric materials widely used in various applications, including wine stopper, floor game and yoga mat, SpaceX rockets, etc. When exposed to sunlight or subjected to friction and mechanical wear, these materials undergo visible aging, manifested as discoloration, scratches, or even craters. Safeguarding such substrates against these harsh conditions necessitates a strategic solution—coating them with a compatible thin film that reinforces protection without compromising their inherent qualities. This approach ensures durability and longevity, addressing the unique challenges posed by sensitive and complex materials like cork and rubber. But both materials are difficult to coat. Besides temperature sensitivity, they show great deformation capability, which forces the deposited coating to be flexible and adherent. In addition, they show high roughness, and the polishing is very challenging, or even impossible. Despite these complexities, this work achieved a breakthrough by effectively depositing TiO_2 and ZnO thin films, opaque to UV yet transparent to visible light, utilizing the magnetron sputtering technique. This innovative approach is strategically employed to preserve the inherent qualities of rubber and cork. In addition, this study provides a detailed examination of the physical characteristics of the deposited films, showcasing the resilience and adaptability of the coatings in response to the unique features of rubber and cork. Notably, the results pertaining to UV light and mechanical wear protection are elucidated, offering a comprehensive understanding of the practicality and efficacy of this advanced protective coating strategy. Amorim Cork Composites and Flowco are two companies' members of this project. The first one belongs to Corticeira Amorim, the most important company in the world regarding cork manufacturing, being Portugal is the main producer and exporter of cork in the world. Flowco is a company devoted to circular economy, which recycles rubber pieces to create new objects for other applications. This supports the relevance of this project to this country.

NEUROTRANSMITTER DETECTION WITH GRAPHENE NANOBIOSENSORS

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Keywords: Graphene, Nanobiosensors, Neural Diseases.

2030 Sustainable Development Goals: SDG3

Dysfunctions of multiple neurotransmitters' transmission cause brain diseases such as depression or schizophrenia. Neural interfaces, bridging brain physiology and external electronic devices, allow brain function monitoring for preclinical research or clinical purposes. Despite recent advances in monitoring electrical brain activity, measuring chemical neurotransmission remains a significant challenge. We have recently developed a platform for robust and ultrasensitive detection of dopamine, an essential neurotransmitter that underlies several brain disorders, based on graphene multitransistor arrays (gMTAs) functionalized with a selective DNA aptamer. Not only did we achieve the lowest limit-of-detection ever reported (1 aM), but we could also detect dopamine with great sensitivity in complex samples such as artificial cerebral spinal fluid and brain homogenates, including in a mouse model of Parkinson's Disease. Herein, we present a novel nanobioelectronic neural interface based on gMTAs that allows monitoring of neurotransmitter opto-evoked release in *ex vivo* brain slices of transgenic mice for preclinical research in neuroscience or pharmacology. By optimizing our gMTAs' fabrication process, we developed an interface with higher sensor density that can accommodate mice's brain slices and allows optogenetic modulation through integrated micro-LEDs. The platform presented in this work can lead the way to novel neurotransmitter sensors suitable for real-world academic and preclinical pharmaceutical research and clinical diagnosis.

SUSTAINABLE MATERIALS FOR ANTI-COUNTERFEITING APPLICATIONS

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Keywords: Anti-counterfeiting, Sodium Alginate, Photoluminescence

2030 Sustainable Development Goals: SDG5, SDG9, SDG11

Sodium alginate (SA) is a linear polysaccharide, derived from alginic acid, comprising 1,4-β-d-mannuronic (M) and α-l-guluronic (G) acids. The incorporation of photoluminescent compounds into the SA matrix allows the development of smart materials able to convert incident electromagnetic radiation of specific wavelengths (e.g. ultraviolet, UV) into emitted electromagnetic radiation of different regions of the spectra (visible or infrared).

In the present work, photoluminescent materials based on SA and different contents (5,10 and 20% wt.) of the luminescent compound sodium tetra(2-thenoyltrifluoroacetonate) europate (III) ($Na[Eu(tta)_4]$) and 1-butyl-3-methylimidazolium tetra(2-thenoyltrifluoroacetonate) europate (III) ($[Bmim][Eu(tta)_4]$) were developed by solvent casting. FTIR-ATR and DSC analysis showed that no relevant changes occurred in the SA structure upon incorporation of the guest compounds. TGA analysis revealed a small increase of thermal stability of the composites with respect to neat SA. The electrical conductivity of neat SA slightly increased with the $Na[Eu(tta)_4]$ content increase. The observed decrease in the Young Modulus is indicative that both luminescent compounds acted as nucleating agents during the SA crystallization, inducing a plasticizing effect in SA. The photoluminescence properties were evaluated and demonstrating the potential of the composites for anti-counterfeiting purposes.

ECO-FRIENDLY LITHIUM-ION BATTERY SEPARATORS BASED ON CARRAGEENAN BIOPOLYMER FOR SUSTAINABLE ENERGY STORAGE SYSTEMS

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Keywords: Battery Separator, Energy; Natural Polymers

2030 Sustainable Development Goals: SDG7, SDG12, SDG13

Rapid technological developments in sensors, actuators and energy storage areas are taken place for advanced devices and applications. Energy storage systems, mainly lithium-ion batteries, are extensively applied in electric vehicles, smartphones, and laptops. Moreover, they play a crucial role integrated with renewable energy sources, storing surplus energy during periods of excess production and supplying it during energy deficits. This approach aligns with the United Nations 2030 Agenda's goal of utilizing sustainable and renewable energy (SDG7) and also meets SDG 13 - combat climate change and its impacts, as these systems allow for the reduction of dependence on fossil fuels and all the harmful consequences that come from the use of this type of energy production.

Although these systems solve some of the sustainability problems, they have other consequences, since most of the materials used in batteries derived from synthetic sources, often rooted in fossil fuels, contributing to current environmental pollution. Addressing this challenge entails substituting synthetic materials with those of natural origin, particularly if sourced from industrial waste or abundant in nature. Natural polymers, derived from biological feedstock, offer notable environmental advantages—such as natural abundance, renewability, biodegradability, and biocompatibility. The use of these materials meets the objectives of the 2030 Agenda in terms of ensuring sustainable consumption and production patterns (SDG12) and combating climate change (SDG13) for the same reasons mentioned previously.

This study details the development of a lyophilized carrageenan membranes with varying polymeric concentrations (1, 2, 3, and 4% wt.) for lithium-ion battery separators. In order to understand the morphology, physicochemical, thermal and mechanical characteristics of the carrageenan membranes were characterized, and their electrochemical characteristics were analysed to verify their performance as battery separators.

The electrochemical characteristics of the membranes are influenced by the carrageenan polymer concentration. With 4 wt% carrageenan, the membranes exhibit ionic conductivity, tortuosity, MacMullin number, and lithium transference number of 1.34 mS cm^{-1}, 3, 7, and 0.48, respectively. Half-cells cathodic assemblies with these membranes demonstrate robust cyclability and rate capability. The discharge capacity values at C/10- and 1C-rates are 145 and 25 mAh g^{-1}, respectively, showcasing outstanding cycling performance and long-term stability.

This study highlights the potential of iota-carrageenan biopolymer membranes, developed through freeze-drying, as separators for the next generation of sustainable batteries.

LOCALIZED SURFACE PLASMON RESONANCE (LSPR) SENSORS BASED ON SPUTTERED NANOPLASMONIC THIN FILMS

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Keywords: Nanotechnology, Sensing, Nanoplasmonic thin films

2030 Sustainable Development Goals: SDG2, SDG3, SDG12

The field of nanotechnology, with its revolutionary innovations, presents many solutions to address and fulfil current global demands. Among its most notable advancements is the development of Localized Surface Plasmon Resonance (LSPR) sensors, a cutting-edge application of nanotechnology that is changing the landscape of sensitive detection mechanisms. The LSPR effect arises from the excitation of localized surface plasmons on the metallic nanoparticle's surface. This effect is particularly observed in nanoplasmonic thin films, which consist of metallic nanoparticles (gold or silver) embedded in various dielectric matrices (oxide or nitrate). Due to their unique optical properties, these films can be used as suitable label-free and highly sensitive optical transducers. After depositing the nanoplasmonic thin films through reactive direct current magnetron sputtering, post-deposition heat treatments at various temperatures are employed to induce the growth of the nanoparticles and enhance their plasmonic behavior. To evaluate the films' performance as LSPR sensors, they are exposed to external stimuli that modify the refractive indices of their adjacent media. These alterations in refractive indices directly impact the plasmonic behavior (LSPR band) of the plasmonic films, which are meticulously monitored using a high-resolution LSPR spectroscopy system. Beyond the sensitivity, selectivity is a critical feature in LSPR sensor technology. This selectivity can be achieved through different immobilization processes by attaching specific binding elements (i.e., proteins, aptamers, and antibodies) to the surface of the thin films. In a proof-of-concept experiment, a biorecognition layer was immobilized on the surface of Au-TiO_2 thin films, providing target analyte specificity. Streptavidin and biotin were the bioreceptor-analyte model chosen to prove the immobilization efficiency and to demonstrate the LSPR sensor potential. The chemical interaction between the aimed target was confirmed by an LSPR wavelength shift, suggesting successful detection. Essentially, the main advantage of the LSPR sensor, using nanoplasmonic thin films, is its versatility since its fundamental principles can be applied adaptively to a wide range of targets, underlining its broad potential in advanced detection applications.

3D-PRINTED MULTILAYER MEMBRANES FOR PHOTOCATALYTIC DEGRADATION OF CIPROFLOXACIN

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Keywords: 3D-printing, Membranes, Photocatalysis

2030 Sustainable Development Goals: SDG6, SDG7, SDG12

The strong technological development and high population growth have generated increased pollutants released into the environment. These pollutants, also called emerging pollutants, are found in products used in everyday life. They are resilient and very stable in the environment, making current conventional water treatment methods ineffective for their removal. New technological concepts based on photocatalytic membranes have proven effective in removing these contaminants. This work focuses on the production, characterization and application of multilayer photocatalytic membranes produced by additive manufacturing. The technique used in this work was direct ink writing (DIW), testing the influence of various printing parameters, such as the printing multiplier and infill. This technique allows the production of multilayer membranes with high reproducibility, controls their shape and morphology and reduces material waste. Thus, TiO_2 nanoparticles were immobilized in a fluoride-co-hexafluoropropylene polyvinylidene (PVDF-HFP) and sodium chloride (NaCl) solution. A layer of this solution was printed on a glass substrate followed by a thermal cycle of 30 minutes at 120^{o}C for solvent evaporation and crystallization of the polymer, then a second layer was printed under the previously printed one and the thermal cycle was repeated. The materials were characterized, and their efficiency in ciprofloxacin photocatalytic degradation was tested. The multilayer membrane exhibited a highly porous structure and hydrophilic behaviour, obtaining positive results in the various photocatalytic tests performed, with up to 44% efficiencies in the degradation of ciprofloxacin (2.5 mg/L) under ultraviolet radiation for 240 minutes, confirming remarkable results in reutilization. These results validate the creation of membranes for environmental remediation by additive manufacturing.

ATTOMOLAR SENSING OF MUTATED BRAIN TUMOR DNA USING ELECTROLYTE-GATE GRAPHENE TRANSISTORS

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Keywords: Circulating Tumor DNA, Graphene Transistors, Early Detection

2030 Sustainable Development Goals: SDG3

Malignant gliomas are the most common primary brain tumors in the central nervous system, with very high morbidity and mortality. Glioblastoma is the most common and malignant subtype of glioma in adults, and even with optimal treatment, the median survival time is only 12-15 months. Detection methods are expensive and invasive for patients and effective only when the disease is already in advanced stages. Recently, early brain tumor diagnosis by detecting trace amounts of circulating tumor DNA in liquid biopsies was demonstrated. This finding could be a game changer in the fight against brain cancer if new versatile biosensing technology is available.

This work develops a novel graphene liquid-gate transistor with an unprecedented low limit of detection. The signal comes from the local gating of the graphene transistor channel, directly exposed to the analyte in solution. The specificity for the target stems from graphene functionalization with synthetic DNA immobilized by non-covalent chemistry. The graphene electrolyte gated field-effect transistor (EG-gFET) chip was integrated with a miniaturized Arduino-compatible reader that provides an easy and “within-seconds” route toward DNA detection. A small amount of mutated synthetic DNA is mixed with a large amount of healthy DNA in a proportion similar to the expected occurrence in clinical samples, e.g., 0.1:100, 1:100, and 10:100. The sensors show sensitivity to the detection of the mutated DNA even though it differs only by one base (single-nucleotide polymorphism) from the unmutated sequence. The lowest mutated DNA detection level was in the femtomolar range. Experiments were performed in synthetic phosphate buffer, spiked undiluted human plasma, and diluted buffer. With an increase of dilution from 1× to 100×, a reversal of the output signal, from negative to positive, is observed. A plasma dilution of 25× enabled bio-sensing results similar to those in an artificial buffer.

These findings denote the potential of graphene field-effect transistors for the record-low level of detection of circulating tumor DNA in a complex matrix required for future clinical use.

INVESTIGATING FLUORINATED POLYMER MATRICES' IMPACT ON SOLID POLYMER ELECTROLYTE PERFORMANCE WITH IONIC LIQUIDS FOR ADVANCED SOLID-STATE LITHIUM-ION BATTERIES

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Keywords: Ionic liquids, Solid polymer electrolyte, Solid-state batteries

2030 Sustainable Development Goals: SDG7, SDG13

This work reports on the effect of the polymer chain polarity, degree of crystallinity and dielectric constant on the electrochemical properties and battery performance of solid polymer electrolytes. Solid polymer electrolytes (SPEs) were produced using different fluorinated polymer matrices, including poly(vinylidene-fluoride), PVDF, poly(vinylidene fluoride-co-hexafluoropropylene) - P(VDF-HFP), poly(vinylidene fluoride-co-trifluoroethylene) - P(VDF-TrFE) and poly(vinylidene fluoride-co-trifluoroethylene-chlorofluoroethylene) - P(VDF-TrFE-CFE) filled with an ionic liquid (IL) (1-Methyl-1-propylpyrrolidinium bis(trifluoromethylsulfonyl)imide – [PMPyrr][TFSI]). It is proven that the use of the different polymers does not significantly affect the thermal properties and morphology of the SPEs. However, regarding mechanical properties and degree of crystallinity, they show lower values for the P(VDF-TrFE-CFE) sample. Concerning electrochemical parameters, all samples present ionic conductivity and lithium transference number values suitable for lithium-ion battery (LIB) applications, with emphasis in the P(VDF-HFP) sample, showing a room temperature ionic conductivity of 6.2 x 10^{-5} S.cm^{-1} and a lithium transference number of 0.71, for P(VDF-TrFE-CFE), associated to a lower degree of crystallinity and a high dielectric constant. Regarding battery cycling assessments, P(VDF-TrFE) shows, under room temperature and C/10 rate, a maximum discharge value of 146 mAh.g^{-1}. Moreover, the P(VDF-TrFE-CFE) sample exhibits outstanding cycling performance at elevated discharge rates, attaining 91 mAh.g^{-1} at 1C rate, while maintaining remarkable stability after 60 cycles, under room temperature conditions. This highlights its considerable potential for utilization in LIBs, attributed to its low crystallinity and elevated dielectric constant. Considering the aforementioned facts, it is proven the suitability of fluorinated polymers for SPEs development when allied to an IL active filler for a next generation of solid-state batteries. Additionally, it offers important insights into the influence of the polymer's dielectric constant and degree of crystallinity on battery performance.

CENTRO DE INVESTIGAÇÃO EM ENFERMAGEM

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COST-EFFECTIVENESS OF A HEALTH PROMOTION PROGRAM IN PRIMARY SCHOOLS AND CHILDREN IN SOCIALLY VULNERABLE CONDITIONS - CLUSTER-RANDOMIZED STUDY (BEE-SCHOOL)

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Keywords: Child, Obesity, Cost-effectiveness

2030 Sustainable Development Goals: SDG3, SDG4, SDG10

Objective: The goal of this study is to evaluate the cost-effectiveness of the health promotion program (BeE-school) concerning the Body Mass Index (BMI) z-score in children attending primary schools facing vulnerable conditions.

Methods: The BeE-school study involved 735 children (51.7% boys, average age 7.7 years old) from 10 primary schools in the Northern region of Portugal. These schools were part of two school groups identified as Educational Territories for Priority Intervention. After the initial assessment, the schools were randomized into two groups: one receiving the intervention (4 schools) and the other not (6 schools). The intervention included educating and training teachers for 16 weeks, their implementation in the classroom, and giving families challenges every two weeks. To assess the program's effectiveness, we measured the children's weight and height using standardized methods. Then we calculated their BMI and used the World Health Organization LMS to compute their BMI z-score (BMIz). We analyzed the data with IBM SPSS V.28, setting our significance level at 5%. The primary outcome was the difference in BMIz from baseline to post-intervention. We used Generalized Linear Model considering the outcome as the difference in BMIz from baseline to post-intervention and the predictor as group allocation (control/intervention). We also adjusted for school groups, school level, length of time from baseline to post-intervention assessment, sex, age, and mothers' and fathers'

education. The costs of the intervention included the three main associated phases: design of the intervention, implementation, and evaluation. Subsequently, we calculated the Incremental Cost-Effectiveness Ratio (ICER). All costs were reported in 2023 euros price.

Results: Intervened children had a significantly reduction in BMIz (b= -0.066, CI 95% -0.121 to -0.012), even after adjusting for confounders (b= -0.112, CI 95% -0.193 to -0.032). The costs for the control group were considered null, as the schools' activity plan was not altered by participating in the study. The total costs of the intervention program were 6 111.00€, dividing it by the intervened children (n=353), we obtain a cost per capita of 17.31€. Considering that the intervention group had a reduction in BMIz of 0.112 compared to the control group, we obtain an ICER of 154.55 euros per unit decrease in BMIz.

Conclusions: The school-based intervention, focusing on teacher training in health promotion and involving families, proved to be effective in improving body composition in socially vulnerable children. Further studies are needed to assess the long-term effects of the intervention.

CENTRO DE INVESTIGAÇÃO EM JUSTIÇA E GOVERNAÇÃO

RESEARCH CENTER FOR JUSTICE AND GOVERNANCE

JUSGOV

THE LEGAL REGIME FOR ENVIRONMENTAL OFFENSES IN PORTUGAL - AN ANALYSIS AIMED AT PROMOTING THE 2030 SUSTAINABLE DEVELOPMENT GOALS

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Keywords: Environmental offenses, Sustainable development goals, Environmental protection

2030 Sustainable Development Goals: SDG9, SDG11, SDG12

In recent decades, we have witnessed a gradual growth of administrative offence law in Portugal, covering all areas of economic activity. This trend was also observed in the environmental field, with the approval of a Framework Law on Environmental Offences (Law No. 56/2006, of 29 August, as amended, hereinafter LQCOA), which establishes the regime applicable to environmental and spatial planning offences.

Considering that, in addition to the payment of the fine imposed, the LQCOA obliges the offender to observe the duties omitted when it is still possible, in the exercise of its licensing, authorisation and/or supervision powers, it is required that the competent administrative authorities ensure the consequent restoration of legality by the offender, restoring the situation prior to the offences and/or mitigating the respective consequences.

Objectives: Based on the selection of three of the 2030 Sustainable Development Goals, this article aims to highlight the importance of the effectiveness of the existing means in sanctioning law in the environmental area, as a way to contribute to its achievement.

Methods: Content analysis of the selected legislation; Case Studies.

Results: It is possible to establish a cause-and-effect relationship between the application of administrative sanctions and the promotion of the 2030 Sustainable Development Goals.

Conclusions: The effectiveness of penalties is the guarantee of the restoration of legality, and consequently, of the protection of the environment.

ARTIFICIAL INTELLIGENCE IN HEALTHCARE: DEFYING THE LEGAL PARADIGM

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2030 Sustainable Development Goals: SDG3; SDG10; SDG16.

Nowadays, it is undeniable that AI is a tool that has come to revolutionize all aspects of knowledge and the health field is no exception. The use of AI techniques and tools can transform the medicine we know today, however, it may often be dubious to leave the health of someone under the decision of a programmed and automated box. This topic can be subject of controversy, as this application presents some ethical, social, and clinical risks.

Despite witnessing the so-called Algorithmic Era, not all of these tools are properly regulated. Clearly, this entire paradigm significantly contributes to the construction of a "black box society." In the words of Frank Pasqual, "inputs come in, outputs go out, but nobody knows how the inputs were transformed into outputs." Most beneficiaries of these mechanisms do not know the basis of their construction, reducing their trust in using them or reveals a complete lack of understanding of how their data is manipulated.

What if the diagnoses made by the algorithm are incorrect and cause actual harm to the user's sphere? What if the algorithm's machine learning experiences a small glitch and triggers discriminatory behavior in diagnosing users?

To frame the topic under study, it’s necessary to start with a comprehensive review of AI, and the existence of specific algorithms can help in the medical field and how it can improve the efficiency of healthcare in various countries, through the analysis of documents and exams, prediction of diagnoses, and even the use of robotics in certain procedures. In turn, a legal analysis will be carried out, primarily at the EU level, focusing on its attempt to pioneer AI regulation for the various legal challenges faced. In this study, we will also address aspects of liability for damages in case of misinformation or incorrect diagnosis of a patient, considering the current possibilities of machine learning and cyberattacks.

Having conducted a meticulous study with a broad legal foundation, we will be able to develop a possibility of supranational regulation, addressing the identified challenges effectively and balancing flexibility with adequate protection of patients' rights, to assist member states in turning the page towards the Digital Era. We cannot neglect to incorporate an ethical analysis, ensuring that the recommendations drawn here align with fundamental ethical principles, progressing consistently and systematically, aiming for a logical conclusion capable of addressing the questions presented earlier within the scope of the investigation.

THE RIGHT TO A JUST TRANSITION IN EUROPEAN UNION LAW: STUDIES ON THE ENERGY TAXATION DIRECTIVE

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Keywords: Right to a just transition, European Union law, Energy Taxation Directive

2030 Sustainable Development Goals: SDG1, SDG7, SDG13

The principle of sustainable development in European Union law is the main parameter for analysing an ecological transition, focusing, however, on the institute of the "right to a just transition" as a fundamental precept of the ecological transition itself.

The review investigates environmental protection in the European Union's primary and secondary legislation and how the principle of sustainable development manifests itself in a Union considered to be governed by the rule of law.

The aim is to analyse the legal concept of "just transition" (which is fundamental to ecological transition) and whether, within European Union law, the "right to a just transition", which must be centred on the citizen, has binding legal force in relation to the law applied by the Member States, or whether it is merely a descriptive notion in the application of environmental protection rules. And how the "right to a just transition" relates to other constitutional principles of EU law: principles of solidarity, proportionality and common but differentiated responsibilities.

In this context, the intention is to detail the meaning of ecological transition from the perspective of the social, economic, environmental and technological dimensions of the principle of sustainable development, and to use the field of energy in the European context as a setting for a more in-depth discussion on the normative stocks needed to pursue the assimilation of the right to a just transition to the ecological transition.

On a practical level, we will use the Energy Taxation Directive as a possible catalyst for a just energy transition, analysing, in particular, the grounds underpinning the proposed revision of this directive, envisaged by the Fit for 55 package, and what conditions are required to characterise when a tax on energy products used to produce electricity can be justified on environmental policy grounds. And whether such reasons can be legitimised through elements capable of discouraging the production and consumption of environmentally harmful products or encouraging the use of other products whose effects are, in principle, less harmful to the environment.

The aim is therefore both to clarify the specific meaning of the precept "right to a just transition" under the concept of the principle of sustainable development in European Union law, together with the fundamental integration of this right into the ecological transition, and to ascertain whether this right find scope and operability in practice when applying European Union law in pursuit of the ecological transition.

ANALYSIS OF THE INTERACTION BETWEEN LAW AND ETHICS IN REGULATING ARTIFICIAL INTELLIGENCE AMID DIGITAL METAMORPHOSIS

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Keywords: Artificial intelligence, Ethics, Digital Metamorphosis

2030 Sustainable Development Goals: SDG8; SDG9; SDG10; SDG16

This abstract presents an outline of the research project, which investigates how/if applied ethics can rehabilitate the liberal conception of human rights amidst the challenges posed by Artificial Intelligence (AI), in an era of 'digital metamorphosis', as coined by Ulrich Beck. It provides an ethical and legal analysis of human dignity given AI's impact on free will, reality, and humanity's role within it. As AI systems operate beyond human reasoning, the study explores our relationship with AI in the pursuit of truth.

To this end, the multidisciplinary analysis of fundamental concepts in the fields of technology, philosophy and law through literature review has proved to be essential. On this basis, we analyse how the development of AI has brought about an unprecedented transformation of society, with the potential to defragment public space, undermine fundamental rights and ultimately erode contemporary democracies. At the core of our study is the idea that the advancement of technology means that human reason is no longer the sole means of comprehending reality, thus raising the question of whether there exists a form of "reasoning" beyond human comprehension and to what extent we possess the models necessary to navigate this uncharted territory without adverse consequences.

Since the European Union's human-centric approach to AI is grounded in ethical values to prevent such negative outcomes, we analyse the role of ethics in the regulatory legal effort: while some argue that it does not sufficiently support the safe advancement of AI for humans, others claim that there is a lack of understanding of ethical codes and how/whether they can be integrated into the development of AI systems. Thus, this study highlights challenges in applying "ethics by design", requiring deeper philosophical knowledge, as well as assessing the framing and long-term feasibility of ethical AI regulation. Furthermore, this research analyses how algorithmic opacity hinders human understanding and accountability, creating power imbalances between technical experts and laypersons.

The collected evidence through a qualitative analysis delineates AI's risks to constitutionalism grounded in the rule of law, democracy and human rights. Therefore, it is our view that its unprecedented development requires investment in regulatory frameworks, as well as flexibility to consider novel ways to address threats to individual integrity, democracy and its underlying principles.

CENTRO DE INVESTIGAÇÃO EM PSICOLOGIA

PSYCHOLOGY RESEARCH CENTER

CIPsi

EFFECTIVENESS OF THE SHORT MOTIVATIONAL PROGRAMME: A RANDOMIZED CONTROL TRIAL

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Keywords: Short Motivational Programme; Motivational Interviewing; Forensic context.

2030 Sustainable Development Goals: SDG3, SDG5

Motivational Interviewing (MI) has proven to be a crucial tool in reducing offending behaviour, preventing recidivism, and reintegrating individuals into society by enhancing the effectiveness of intervention programs with a heightened focus on the needs of each person. The aim of this study is to adapt and culturally validate the Short Motivational Programme (SMP), and to implement and assess its effectiveness in terms of both process and outcome (i.e. clinical change and inter-group and intra-subject change) among individuals sentenced to custodial and non-custodial measures using a randomised controlled trial (RCT). Sixty individuals (30 female and 30 male) will be screened for eligibility and assigned to one of four conditions: 1) individuals in prison receiving intervention; 2) individuals in prison without intervention; 3) individuals in the community receiving intervention; and 4) individuals in the community without intervention. Participants will complete instruments assessing motivation to change, criminogenic beliefs, and blame attribution in four moments: baseline, post-treatment, 3-month follow-up, and 6-month follow-up. Upon completion of the program, a final assessment will be conducted to assess the quality and integrity of the implementation of the SMP and the psychologist's performance. This evaluation will be conducted using the Motivational Interviewing Treatment Integrity (MITI 4.2.1), a qualitative methodology measuring the fidelity and quality of MI. Considering previous studies (e.g., Austin et al., 2011), it is anticipated that the SMP will exhibit significant changes in variables such as motivation to change, attribution of guilt for the crime, commitment to the intervention, recidivism, and dropout. Through this study, we aim to contribute to a deeper scientific understanding of the impact of MI in the forensic context, facilitating the integration of mechanisms to support interventions with perpetrators. The ultimate goal of these mechanisms is to enhance reintegration and prevent recidivism in Portugal.

EMPATHY AND EXECUTIVE FUNCTIONING IN INCARCERATED WOMEN: COMPARATIVE ANALYSIS BETWEEN VIOLENT AND NON-VIOLENT CRIMES

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Keywords: Female Criminality, Empathy, Executive Functioning

2030 Sustainable Development Goals: SDG5.

The lack of empathy and deficits in executive functioning are often related to antisocial behavior which may increase the likelihood of involvement and perpetration of criminal acts. In the Portuguese context, scientific research focused on the phenomena of female criminality has been neglected over the years, with only a small number of studies dedicated to the study of how empathy and executive functioning relate to that matter.

Therefore, the present study aims to analyze empathy and executive functioning in incarcerated women who committed violent and non-violent crimes.

The research is expected to involve 102 female participants from different prison facilities in Portugal. The participants were asked to complete a survey that sought information on their sociodemographic and sociolegal backgrounds, the Basic Empathy Scale, and the Frontal Assessment Battery.

Based on prior research, the following research hypotheses can be developed: women who are incarcerated tend to have lower levels of empathy and greater deficits in executive functioning; incarcerated women who have committed violent crimes exhibit similar levels of empathy as those who have committed non-violent crimes; incarcerated women who committed violent crimes tend to demonstrate higher deficits in executive functioning compared to non-violent offenders. Additionally, there appears to be a positive correlation between empathy and executive functioning in incarcerated women.

This study aims to provide information on the functioning of women who committed crimes in Portugal, along with its underlying mechanisms. It also hopes to reduce some of the discrepancies that exist between research conducted on men and women. In summary, the study aims to shed more light on the nature of female criminality in Portugal.

"A RAINBOW SCHOOL PROGRAM": DEVELOPMENT AND ASSESSMENT OF AN INTERVENTION WITH EDUCATIONAL AGENTS TO PREVENT VICTIMIZATION OF LGBTQ STUDENTS

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Keywords: Intervention program; Educational Agents; LGBTQ Students

2030 Sustainable Development Goals: SDG3, SDG4, SDG16

The LGBTQIA+ population faces daily challenges, which impact social, work and school inclusion. LGBTQIA+ students experience high levels of victimization, generating feelings of insecurity, poor academic performance and high rates of school absenteeism, feeling unprotected and little understood by educational agents (EA).

Although most of these abusive behaviors and discrimination are carried out by peers, EA can also discriminate against LGBTQIA+ students, by revealing unpreparedness to deal with theme on daily basis, due to lack of skills, awareness, needs and challenges of this population. Causing a barrier to social inclusion and revictimization of these students.

The present study aims to develop and test the effectiveness of a group psychological intervention program, together with EA, to promote school inclusion as a victimization prevention strategy. The construction of it, will be based on the literature, using a systematic review and a meta-analysis. A focus group will also be held with experts and partner entities, with aim on understanding the main problems and needs of the LGBTQIA+ population. A literacy scale on school inclusion of the LGBTQIA+ population will also be constructed, which allows understanding the literacy level of EA in relation to the school inclusion of LGBTQIA+ students, identifying the main needs to be met with the implementation of the intervention program.

This is a longitudinal study, with a quasi-experimental design, and will feature pre and post intervention assessment, using an assessment protocol that integrates quantitative measurement instruments and semi-structured interviews. We estimated that the follow-up will be carried out between 6-8 months after implementing the program, allowing us to understand the stability of the results over time.

It is expected that participants will be able to understand the behaviors, vulnerabilities, fears and weaknesses of LGBTQIA+ students, adopting more effective intervention strategies, capable of minimizing the risk of victimization in this population on school context, promoting a higher level of literacy in school inclusion of LGBTQIA+ students.

DEVELOPMENT AND EFFECTIVENESS ASSESSMENT OF AN INTERVENTION FOR INTERNET CHILD SEX OFFENDERS USING A RANDOMIZED CONTROL TRIAL

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Keywords: Online Sexual Offending, Intervention Program, Randomized Control Trial

2030Sustainable Development Goals: SDG4, SDG16

Internet-child sex offenders (I-CSO) are a cause of public concern due to the negative impact they have on their victims, the sense of insecurity they instil in the community, and the increase in the demand for child pornography that they contribute to. As these behaviors become more prevalent, there is a pressing need for the development of intervention programs tailored to the needs and characteristics of I-CSO.

In the Portuguese context, to best of our knowledge, there are no specific interventions targeting I-CSO. Research on the characteristics of I-CSO suggests that they differ in many ways from other child sex offenders, indicating a different risk of recidivism. Consequently, interventions should be designed based on these differences and specificities.

This study aims to design and implement an intervention protocol for I-CSO serving community and prison sentences, and to evaluate its effectiveness in terms of both process and outcome. The intervention program's development will be informed by a review of literature, identifying techniques deemed most effective with the I-CSO population. Subsequently, a population characterization study will be conducted to pinpoint the specific criminogenic needs of the Portuguese I-CSO, guiding intervention objectives based on specialized research and integrating proven theoretical models.

The program will encompass individual and group components, addressing criminogenic needs and accommodating diverse learning styles. A randomized clinical trial, adopting a longitudinal design, will incorporate pre/post-intervention assessments and follow-ups at 3 and 6 months, with intervention and control groups in both community and prison settings. We expect to have eight groups with 6-8 individuals each, two intervention groups and two control groups of I-CSO serving prison sentences, and two intervention groups and two control groups serving community sentences. Evaluation will also include participant feedback and regular program assessments.

Additionally, semi-structured interviews with program completers will provide deeper insights into the intervention and the process of change. This integrated approach aims to align study objectives with methods allowing a comprehensive analysis of the intervention protocol's effectiveness, addressing the specific needs of I-CSO in both community and prison settings.

We expect to reduce the risk factors, equip offenders with information and skills to overcome their behaviors, and reduce the risk of recidivism. Furthermore, the program seeks to protect children by lowering the likelihood of them falling victim to sex crimes, a critical concern given their vulnerability.

DARK TRIAD, SEXTING, AND ONLINE GROOMING: MALEVOLENT SIDE OF ONLINE SEXUAL ACTIVITY IN YOUNG ADULTS

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Keywords: Sexting, Online grooming, Dark Triad

2030 Sustainable Development Goals: SDG3, SDG16

Young adults frequently engage in Online Sexual Activities (OSA) through Information and Communication Technologies (ICT) to maintain intimate relationships and explore their sexuality. OSA encompasses activities such as sexting and online grooming, and the prevalence of these behaviors has surged with the widespread adoption of ICT in interpersonal communication. While the link between personality traits and OSA is well-established, scant attention has been given to the association between the Dark Triad personality traits and sexting and online grooming behaviors. Existing literature indicates positive correlations between the Dark Triad traits and sexting, with higher levels of sexting serving as a predictor for grooming. Furthermore, there is a notable absence of validated instruments for assessing these phenomena within the Portuguese population.

Therefore, the main objective of this study is to characterize the prevalence of sexting and online grooming among young Portuguese adults and examine their potential association with personality traits. Specifically, this study aims to: i) validate and describe the psychometric characteristics of The Sexting Scale and The Grooming Scale for the Portuguese population; ii) explore the relationship between sexting experience and Dark Triad personality characteristics; iii) explore the relationship between online grooming experience and Dark Triad personality characteristics.

Conducted as an exploratory cross-sectional study with a quantitative approach, the sample will consist of 260 participants aged 18 to 25 years. Based on existing literature, it is anticipated that The Sexting Scale and The Grooming Scale instruments will demonstrate satisfactory internal consistency and divergent and convergent validity. High levels of sexting are expected to be associated with online grooming, and both high levels of Dark Triad traits and online grooming experiences are expected to be linked with sexting.

This study aims to contribute valuable insights into the prevalence of sexting and online grooming among young adults in Portugal, informing preventive and intervention strategies addressing internet-related risks. Additionally, it is hoped that this research will encourage further investigations into these phenomena within the Portuguese context.

SOCIAL INTEGRATION SKILLS DURING IMPRISONMENT: A LONGITUDINAL STUDY

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Keywords: Prison, Detained persons, Reintegration, Rehabilitation, Risk and Protective Factors, Longitudinal Study

While numerous studies have focused on recidivism (or its absence) as the primary measure of successful community reintegration, it is important to broaden this perspective.

This study aims to evaluate the social integration capabilities of individuals upon entering the open regime (facing the interior or exterior), as well as 6 and 12 months after entering the open regime. We will also seek to include an assessment after release from prison. We intend to collect data from 100 males aged 18 or over. Several psychometric instruments will be used, including a measure of social integration as the dependent variable, measures of criminogenic factors, physical and mental health, coping strategies, violence, and crime as independent variables. The independent variables will only be administered at the first assessment moment. The assessment after release from prison will be conducted by sending the social integration measure to participants by post or email, or through telephone questioning.

This approach will allow for an update of knowledge on important indicators in the process of transitioning from prison to society, not limited to recidivism. Furthermore, we will be able to assess whether the Portuguese prison system helps individuals to develop their social integration and identify the factors necessary for developing these skills. Our research may provide valuable insights that can guide correctional policies and, ultimately, promote the rehabilitation of detained persons.

ONLINE GROOMING OF CHILDREN: PREVALENCE AND IMPACT

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Keywords: Online grooming, child, prevalence, impact

2030 Sustainable Development Goals: SDG3, SDG4, SDG16

Grooming is a premeditated behavior aimed at enticing, typically, underage victims with a specific goal. Online grooming is understood as the sexual enticement of minors, a process through which the offender prepares the child by gaining their trust, with the aim of obtaining content, maintaining contact, or developing sexual interactions, with or without physical contact, either directly or via the internet, while keeping it a secret. Despite being a concern in international studies, it is relatively unknown in the Portuguese context. Online sexual violence against minors has been on the rise over the years, driven by the increasing challenges and risks of the internet and/or social networks. In 2016, an exploratory study in Portugal revealed a 20.5% victimization rate due to online grooming. The Portuguese Association for Victim Support (APAV) report from 2016 to 2020 indicates that the solicitation of minors for sexual purposes represents 2.9% of reported cases. In Portugal, online grooming remains a mystery to the majority of children and a phenomenon relatively overlooked by the scientific community and society at large.

However, research on this issue and its impact, especially existing support responses, is scarce. Therefore, this study aims to adapt and validate an instrument for the Portuguese population ascertain the prevalence in children aged 12 to 18 who are victims of online grooming and impact of this type of victimization, as well as the characteristics of victims and offenders.

These findings open possible directions for research on the characteristics and consequences of online grooming

It is estimated that the results of multivariate and content analyses will indicate effective intervention modalities in addressing and preventing online grooming.

EMOTIONAL PROCESSING IN MALE PRISONERS: COMPARING PSYCHOPATHS AND NON-PSYCHOPATHS

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Keywords: Emotional Processing, Male Prisoners, Psychopaths

2030 Sustainable Development Goals: SDG16

Emotional processing involves perception, expression, and emotional regulation, which are central to interpersonal dynamics and daily decisions in a prison environment. Psychopathy, characterized by traits such as lack of empathy, manipulation, and antisocial behaviour, is often associated with deficits in emotional processing. Psychopathic individuals tend to exhibit a low physiological response to stimuli related to the suffering of others, supporting the relationship between these two variables.

The main aim of this study is to investigate the differences in emotional processing between psychopathic and non-psychopathic male inmates. Specifically, the study aims to determine whether there is a relationship between higher scores on the affective facet of psychopathy and greater deficits in emotional processing.

This study employs a quantitative methodology and a sample of 176 male inmates from prisons in northern Portugal who are considered imputable and over 18 years old. The study will consist of two groups: one composed of individuals with psychopathy and the other composed of individuals without psychopathy. The study will use three measures: a socio-demographic and socio-legal questionnaire, the Self-Report Psychopathy Scale-Short Form, and the Emotional Processing Scale (EPS-25).

Psychopathic inmates are expected to exhibit deficiencies in emotional processing, particularly in areas such as empathy, emotion recognition, and emotion regulation. High scores on psychopathic affective traits, such as lack of remorse or empathy, are predicted to be correlated with these deficiencies. These findings may reveal unique emotional processing patterns in psychopathic individuals, contributing to a deeper comprehension of psychopathy.

This study explores the relationship between psychopathy and emotional processing. The conclusions of this study could contribute to the development of more effective strategies in the area of rehabilitation and prevention of antisocial behaviour, as well as improving mental health professionals' understanding of the challenges faced by individuals with psychopathic traits.

EXECUTIVE FUNCTIONING AND EMPATHY IN MALE INMATES: A COMPARISON BETWEEN VIOLENT AND NON-VIOLENT CRIMES

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Keywords: Empathy, Executive Functioning, Inmates

2030 Sustainable Development Goals: SDG16

Empathy can be seen as a protective factor that reduces the likelihood of criminal behaviour. On the other hand, deficits in executive functioning are related to self-regulation problems, and individuals with executive deficits are more likely to manifest aggression. Empathy involves comprehending and reacting to the emotional experiences of others, while executive function plays a role in regulating our emotional responses. This interaction between executive functioning and empathy suggests that executive function can either enhance or diminish empathic responses. Research indicates that violent offenders exhibit lower levels of empathy and higher executive deficits compared to non-violent offenders, establishing a positive correlation between these variables.

Thereby, the main aim of the present study is to assess executive functioning and empathy in male inmates, analyse the relationship between them, and explore the potential differences between individuals who committed violent crimes and individuals who committed non-violent crimes.

A quantitative exploratory cross-sectional study will be conducted, in which participants will be recruited from Portuguese male prisons. The sample will include 176 participants, who will be divided into two groups, one composed of individuals who have committed violent crimes and the other of individuals who have committed non-violent crimes. In order to collect the data needed, a socio-demographic and socio-legal questionnaire will be completed by the participants, as well as the Basic Empathy Scale (BES) and the Frontal Assessment Battery (FAB).

Based on research, in this investigation it is expected that individuals in prison for violent crimes will show greater executive deficits and less ability to express and feel empathy compared to non-violent ones, and that executive functioning and empathy will be positively correlated.

This study can be considered highly significant as it could contribute to understanding the relationship between executive functioning and empathy in prisoners, increasing research on this topic in Portugal.

CENTRO DE QUÍMICA

CHEMISTRY CENTRE

CQUM

COMPUTATIONAL ELUCIDATION OF THE INHIBITION OF MYOGLOBIN AGGREGATION BY POLYETHYLENE GLYCOL

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Keywords: Myoglobin, Polyethylene Glycol, Protein Aggregation

2030 Sustainable Development Goals: SDG3

Protein folding is the process that leads a protein to acquire its native conformation after being synthesized in the cells. In most cases, this process is mandatory for proteins to become active and function properly. However, several factors could lead the protein to a non-native folding state. Often these non-native states aggregate leading to protein inactivation and loss of function.

Protein aggregation is a characteristic feature of neurodegenerative diseases, like Alzheimer's, with few therapeutics available for both prevention and treatment. Thus, understanding the molecular process behind protein aggregation and defining strategies that may prevent it is of great relevance.

One way to prevent protein aggregation is changing the environment using protein-stabilizing compatible excipients, such as polyethylene glycol (PEG). In this work, molecular dynamic simulations were employed to elucidate how PEG interacts with native and denatured myoglobin (myoWT and myoD), which is used as a model to study (un)folding and aggregation.

For the simulations, two units of myoD and myoWT in an aqueous system were considered. It was added ethylene glycol, PEG2 (two units of ethylene glycol), PEG4, PEG8, and PEG12 to the system at a concentration of 2%, 5%, and 10% (m/m). Visualization inspection and quantitative analyses were performed to disclose the interaction pattern of PEG with both myo states.

The data shows no aggregation between the two units of myoWT. As for PEG, there is an increase in interactions with myoWT as the molecular weight increases, and for PEG8 and PEG12, a globular structure is formed. For myoD, PEG has similar behavior but myo aggregation is seen in aqueous solution and in the presence of ethylene glycol, PEG2, and PEG4. In the presence of PEG8 and PEG12 aggregation is inhibited because the two units of myoD interact with the globular structure instead of with each other.

EUGENOL AS BUILDING BLOCK OF POTENTIAL INSECTICIDES

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Keywords: Essential Oils, Eugenol, Insecticides

2030 Sustainable Development Goals: SDG2, SDG12, SDG13, SDG15

Today's demographic situation demands that their food needs be met by improving the productivity of agricultural crops through the application of pesticides. Initially, these were a plausible solution, but the uncontrolled use of synthetic pesticides in agriculture has caused countless problems for the environment. Natural products can be a sustainable alternative as potential sources of pesticides, using essential oils and plant extracts in the construction of formulations for crop protection.

Essential oils are complex and synergetic mixtures that have promising antioxidant activities, mainly due to the presence of phenolic compounds. Eugenol (trivial name of 4-allyl-2-methoxyphenol), a volatile phenylpropanoid, is the main constituent of clove essential oil. It is a functional ingredient in many products used in the pharmaceutical, food and cosmetics industries, as well as in agriculture, since it exhibits a varied spectrum of action, such as antioxidant, antifungal and antimicrobial. Due to its biological potential, the incorporation of eugenol into the design and synthesis of pesticides, as a more sustainable alternative to conventional products, to control pests in agricultural crop is of great interest.

In structural terms, eugenol is an allylbenzene, which has a double bond with capability for further functionalization, namely through epoxidation reaction. An epoxide is a reactive synthetic intermediate that can be open using an appropriate nucleophile. Furthermore, eugenol is a phenolic compound that can participate in esterification reactions with carboxylic acids.

In the present work, semisynthetic eugenol derivatives were obtained through epoxidation reaction followed by epoxide opening with nucleophiles, such as sodium azide, sodium cyanide and sodium nitrite. The other synthetic route adopted was Steglich esterification, a mild variation of the usual reactions using *N*,*N'*-dicyclohexylcarbodiimide as coupling reagent and 4-dimethylaminopyridine as catalyst. All the compounds obtained were compared to a commercial synthetic insecticide and tested against *Sf9* (*Spodoptera frugiperda*) insect cell line to conclude their potential as insecticides.

DEVELOPMENT OF NATURAL POLYMER-BASED MEMBRANES FOR ENVIRONMENTAL REMEDIATION

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Keywords: Adsorption, Chromium, Sustainable

2030 Sustainable Development Goals: SDG6, SDG7, SDG12

The pollution of aquatic environments is a growing issue linked to population growth and uncontrolled anthropogenic activities. Among many contaminants, especially attentions are being addressed to the contaminants of emergent concern (e.g., pharmaceuticals, heavy metals), as potentially impacting human health and the environment. The specific impacts are not completely known yet since its release to the environment is neither legislated nor monitored. Among this class of pollutants, heavy metals, in particular hexavalent chromium (VI), is toxic and potentially carcinogenic, causing liver and kidney damage, internal bleeding and alterations to the respiratory system in humans. In addition, there is bioaccumulation of Cr(VI) in aquatic organisms, which can lead to death. In the midst of growing environmental concerns, the sustainability of materials is a focal point. This work proposes the use of materials of natural origin with properties capable of adsorbing Cr(VI), thus providing a sustainable alternative for its remediation from water sources.

In this study, membranes based on chitosan (CS) and chitosan/lignin (CS/L), with different percentages of lignin (0.01, 0.025 and 0.05g), were developed by solvent casting technique. This method is characterised by its ease of use and low cost. Subsequently, physical and chemical characterisations, such as SEM, EDS, FTIR-ATR, XRD, DSC and mechanical properties, were carried out. The films were then tested for their efficiency and ability to remove Cr(VI). This analysis also included the study of the effect of varying the pH and the initial concentration of Cr(VI) to analyze the impact on the adsorption of the contaminant. In addition, the reuse of these membranes during three adsorption/desorption cycles was tested.

The physicochemical characterizations revealed that the inclusion of lignin did not compromise the chemical and thermal stability of the chitosan structure, leading to improved mechanical properties. In the Cr(VI) adsorption tests, the CS and CS/0.01L membranes showed the best results in terms of removal efficiency, > 90%, which depends on pH and initial Cr(VI) concentration.

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SHAPE MEMORY ALLOY ARTIFICIAL MUSCLES – CURRENT STATE OF RESEARCH AND DESIGN PROPOSAL

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Keywords: Shape Memory Alloys, Artificial Muscles, Soft Exoskeletons

2030 Sustainable Development Goals: SDG3

This abstract provides a comprehensive overview of a review that addresses the current state of research of soft artificial muscles based on shape memory alloys (SMA) for actuation in soft exoskeletons. The document not only explores the fundamental principles and mechanisms of SMA-based actuation but also delves into various aspects of their operation, such as thermomechanical behaviour, control strategies, and heating/cooling techniques. Additionally, the review highlights notable examples from the literature and presents a design proposal for an SMA-based artificial muscle, informed by the conclusions drawn from the literature research.

The review emphasizes the potential of SMA artificial muscles in soft exoskeleton applications due to their advantageous characteristics, including low weight, small volume, ease of textilification, and substantial power generation. The core concept of SMA actuation, driven by the shape memory effect (SME) of near-equiatomic NiTi SMAs, is discussed in detail. The document compares the actuation metrics of SMA-based actuators with those of conventional soft actuators and assesses their compatibility with the kinematic and kinetic requirements for effectively assisting activities of daily living (ADLs).

The work further details a systematic review based on the PRISMA methodology of validated SMA actuators in literature. The findings include the extraction of key characteristics such as actuation metrics, form, heating/cooling strategies, control methods, and bandwidth. The results are thoroughly discussed, emphasizing the drawbacks of each implementation, and identifying current gaps in knowledge within the field. Concretely, it explores trade-offs associated with the different SMA actuator characteristics, including form variations (wire, spring, knitted), Ni and Ti percentages, size, textilification, control methods, and heating/cooling strategies. Finally, it highlights the need for novel active cooling and low-level, model based, sensorless control strategies to increase actuator bandwidth, identifying this field a the most promising for future research.

Finally, the work details a design proposal for an SMA-based actuator, providing insights into the decision-making process, discussions on design choices, and justifications based on the outcomes of the systematic review.

Overall, this review serves as a comprehensive resource for researchers and practitioners in the field of soft exoskeleton development, offering valuable insights and directions for future research.

ON-CHIP OPTICAL MICROSYSTEM FOR *PLASMODIUM FALCIPARUM* MALARIA DETECTION

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Keywords: Spectrophotometry, Diagnosis, Malaria

2030 Sustainable Development Goals: SDG1, SDG3, SDG4

The limitations in the currently used diagnostic methods pose challenges to effective malaria control and elimination. To overcome this, herein, optical spectrophotometry is explored for the detection and quantification of low-level *Plasmodium falciparum* infections. Specifically, we characterize the optical spectra of healthy and infected samples and design, simulate, and fabricate an on-chip optical detection microsystem.

For a preliminary characterization of samples, a 200 W Halogen source directed light onto the sample and the subsequent transmitted or reflected light was detected on a top-bench spectrophotometer. The fabricated CMOS microsystem features a sophisticated array of 16 n+/p- substrate silicon junction photodiodes functioning as photodetectors, coupled with 16 current-to-frequency converters, and was tested with healthy and *P. falciparum*-infected red blood cells (RBCs).

The results indicate that the absorbance and reflectance spectra of the samples in the 400 – 800 nm range can be mimicked by a set of 16 discrete wavelengths. This facilitates the detection (when integrated into a diagnostic device), allows the detection of low level parasitaemia (12 parasites/μL of RBCs) and potentially disease quantification and stage differentiation. Additionally, the designed microsystem was validated through transmittance detection of healthy RBCs and infected samples of 12, 25 and 50 parasites/μL.

Overall, our study demonstrated that the sensitivity of spectrophotometry is competitive to the one of the gold standard diagnostic methods, affirming its potential for malaria diagnosis. Furthermore, the incorporation of these technologies into an affordable and rapid diagnostic device addresses the escalating clinical demands for improved malaria control and elimination.

FALL RISK ASSESSMENT IN OLDER ADULTS: TOWARDS REAL-TIME & CONTINUOUS ESTIMATION

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Keywords: Fall Risk Assessment, Daily Activities, Artificial Intelligence

2030 Sustainable Development Goals: SDG3

Falls are a prevalent cause of injuries in the elderly, escalating treatment costs and emphasizing the importance of real-time Fall Risk Assessment (FRA) tools. While wearable devices, such as waistbands or smartwatches linked to smartphones, have been explored for FRA integration, further refinement is imperative. This study addresses the critical need for strategies that promptly identify risky situations, considering a broad spectrum of factors, to assist seniors and mitigate fall consequences. The primary objective is the development and validation of a continuous, objective, and multifactorial FRA tool.

The envisioned FRA strategy emphasizes inertial data-based recognition of Activities of Daily Living (ADLs) in the elderly and employs a tripartite modular architecture for real-time fall risk assessment, incorporating a waistband with an inertial sensor and an eHealth application. Each module, using Artificial Intelligence (AI) methods, scrutinizes a widespread range of risk factors, including movement data, biological data, environmental changes, and behavioural aspects to give an objective and personalized FRA.

The validation of the envisioned tool commenced with the ADLs recognition module, employing an inertial data collection protocol. Data from 8 unrestricted ADLs, including fast transitional ADLs, performed by 54 senior individuals in continuous and unrestricted conditions, were gathered in 6 different nursing homes. A rigorous 2-step validation and optimization of various Deep Learning (DL) models (CNN, LSTM, and CNN-LSTM) was performed, revealing highly satisfactory subject-independent recognition results and a trend towards optimizing window size for enhanced algorithm performance.

The CNN-LSTM architecture demonstrated the most promising results, achieving the highest accuracy across all ADLs in a Leave-p-out cross-validation for 9 test subjects. While not uniform across all ADLs, the potential of neural networks highlights AI algorithms as future solutions for recognizing unrestricted ADLs, promising continuous and real-time FRA in older adults. Future work should focus on refining DL models, acquiring additional data from elderly individuals and validating the remaining modules of the defined FRA strategy.

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DEVELOPING A 3D WEB-GIS MAPPING PLATFORM TO SUPPORT SEISMIC VULNERABILITY ASSESSMENT OF URBAN AREAS: AN INTRODUCTION

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Keywords: Earthquake, Urban Resilience, Decision support tool

2030 Sustainable Development Goals: SDG1, SDG9, SDG11

In 2020, natural disasters globally affected around 100 million people, causing substantial economic and human losses. The population density in low-lying coastal or riverside areas heightens the risk of significant impacts from natural disasters. Due to its location, Portugal's tectonic environment induces low to moderate seismic and co-seismic hazards with the potential for considerable economic and human losses, especially in urban areas like Lisbon, underlying the urgency for enhanced risk assessment and preparedness strategies. While robust seismic risk models exist for Lisbon, the absence of a user-friendly tool capable of automatically estimating real-time earthquake damages and safe rescue pathways is a notable gap. This is where the proposed 3D web-GIS platform will play an important role.

This platform aims to provide dynamic maps that illustrate the city's vulnerability to these natural disasters. The incorporation of 3D model buildings will enhance the visualization and communication of potential impacts and losses, thus facilitating more effective preventive and response measures. The platform's dynamic nature allows the integration of various models, including those for assessing building collapse risks and identifying priority areas and safe rescue routes. With dynamic, visual, and interactive representation of seismic risk data, the platform will enhance seismic vulnerability comprehension and improve the decision-making process for various stakeholders. For policymakers and urban planners, this platform will offer a powerful tool for visualizing the potential impacts of seismic events, aiding more effective urban planning and risk mitigation strategies. It will also provide emergency response teams with critical information for swift and safe response actions in the aftermath of an earthquake, potentially saving lives and reducing economic losses, ultimately contributing to safer, more resilient urban environments.

The PhD thesis, entitled "Developing a 3D Web-GIS Mapping Platform to Support the Seismic Vulnerability Assessment of Urban Areas," which forms the basis of this abstract, is in its early stage. The research is currently in a comprehensive literature review, concentrating on seismic risk modelling, specifically in Lisbon City. This initial stage is crucial for identifying potential gaps and opportunities in current methodologies, which will inform and guide the development of the web-GIS platform.

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SPATIOTEMPORAL PROFILING OF GENE EXPRESSION DURING SARCOID GRANULOMA FORMATION

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Keywords: Sarcoidosis, RNA-sequencing, IL-17 signalling

2030 Sustainable Development Goals: SDG3, SDG9, SDG10

Granulomatous lung diseases encompass an array of disorders caused by both infectious and non-infectious agents in combination with genetic susceptibility and environmental factors. Sarcoidosis is a multisystemic disease with unknown etiology characterized by the presence of epithelioid, non-necrotizing granulomas in several organs, predominantly the lungs. The granulomatous response involves a stepwise program in which a series of macrophage transformations recruits additional cells to produce structural and molecular modifications. Nonetheless, the regulation of the local transcriptional landscape during granuloma formation.

To fulfil this gap, we have resorted to a mouse model of granuloma formation to dissect the transcriptional dynamics of isolated granulomas during their formation, namely the early (day 0), intermediate (day 2) and late (day 4) stages.

RNA-sequencing analysis of microdissected granulomas revealed that the majority of the differentially expressed genes (DEGs) is noticeable two days after eliciting granuloma formation (568 DEGs) with genes like and *Retnla*, *Mmp12*, *Saa3* and *Acod1* being upregulated and directly/indirectly involved in the inflammatory response and genes like *Tmem100* and *Dpep1* implicated with peptide metabolism downregulated. At this time point, the most pronounced pathways included the ones related with chemokines, chemokine receptors, and the complement system. Processes related with structural alterations are more pronounced in later stages, such as extracellular matrix organization and pathways related to fibronectin matrix formation. Our results also point out classical pathways involved in the inflammatory response such as TNF, NF-Kβ and complement cascade. Besides, IL-17 signalling also appears to be critically implied throughout the granuloma formation process (gene ratio of 0.23). Particularly, DEGs related with IL-17-mediated signals are distinctively expressed across all stages of granuloma formation, and more prominently at the intermediate stage.

Overall, the spatiotemporal mapping of the transcriptomic signatures upon granuloma formation pinpoint the most important pathways, and individual genes as potential targets to further explore using pharmacological inhibition or *in vitro* models.

GENETIC VARIATION IN IL-37 INFLUENCES THE IMMUNE RESPONSE TO ASPERGILLUS FUMIGATUS AND PREDISPOSES TO FUNGAL DISEASE AFTER STEM-CELL TRANSPLANTATION

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Keywords: Aspergillosis, Antifungal Immunity, Interleukin-37

2030 Sustainable Development Goals: SDG3, SDG9, SDG10

Invasive pulmonary aspergillosis (IPA) is a life-threatening infection, particularly among patients undergoing chemotherapy or allogeneic hematopoietic stem cell transplantation (HSCT), caused by the fungal pathogen *Aspergillus fumigatus*. Among several clinical risk factors, genetic variations may render individuals more susceptible to IPA. Therefore, the identification of allelic patterns that predispose to a higher risk of disease is essential for risk stratification and consequently the development of pre-emptive diagnostics for patients at high risk of IPA.

The balance between pro- and anti-inflammatory responses is a prerequisite for successful antifungal host defences. Although inflammation is an essential component of the protective response to fungi, its dysregulation may significantly worsen fungal diseases and limit antifungal immune responses. A newly described negative regulator of inflammatory responses is interleukin-37 (IL-37), an immunosuppressive cytokine from the IL-1 family that exerts broad protective effects in autoimmune and inflammatory diseases. In the context of infection, IL-37 was demonstrated to be able to inhibit inflammasome activation and disease severity in murine aspergillosis. IL-37 is produced by several non-immune and immune cells, including macrophages, and has been described as a fundamental suppressor of innate and acquired immunity.

In this study, we aimed to dissect the contribution of genetic variation within the IL37 gene to the risk of IPA in high-risk patients.

Our results demonstrate that the donor rs3811047 variant in IL37 was significantly associated with an enhanced risk of IPA after transplantation, as demonstrated by the higher cumulative incidence of IPA displayed by patients who received a transplant from donor with the AA or the GA genotypes than patients with GG donors (34% and 16%, respectively, P=0.0006). Supporting these data, we found that the rs3811047 variant in *IL37* regulated alveolar cytokine production in patients, with AA or GA genotype carriers displaying lower levels of TNF and IL-1β in the bronchoalveolar lavage fluids (BALs) when compared to patients with the GG genotype. Moreover, human monocyte-derived macrophages from healthy donors from AA or GA donors displayed an impaired ability to eliminate the fungus in an *in vitro* infection model, compared to GG macrophages.

Overall, our results uncover, for the first time, the putative clinical relevance of genetic variation in IL-37 in the regulation of susceptibility to IPA.

ENHANCING MALARIA ELIMINATION STRATEGIES IN THE DOMINICAN REPUBLIC: EVALUATING RAPID DIAGNOSTIC TEST ACCURACY AND UNRAVELING PARASITE GENETIC DIVERSITY

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Keywords: Malaria, Rapid diagnostic test, Molecular surveillance

2030 Sustainable Development Goals: SDG3, SDG10, SDG11

Malaria remains a significant public health concern in tropical regions globally, characterized by challenges such as limited diagnostic tools, drug resistance, and the compounding impact of the COVID-19 pandemic. Dominican Republic (DR), a participant country in the E2025 WHO program for malaria elimination, confronts distinctive challenges due to ongoing transmission of *Plasmodium falciparum*. This study meticulously assesses the accuracy and limitations of malaria Rapid Diagnostic Tests (RDTs) in DR, delves into the genetic diversity of *Plasmodium spp*, and explores factors contributing to the high prevalence of *P. falciparum* on the island.

A comprehensive molecular analysis involving 1,653 samples from suspected malaria cases in Dominican Republic, our study uncovered a 2.3% false negative rate for Rapid Diagnostic Tests (RDTs). Employing quantitative polymerase chain reaction (qPCR), we identified that all false negative RDTs contained *Plasmodium spp*. at low-level parasitemia, underscoring the imperative for more sensitive diagnostic tools, such as molecular analyses. Delving deeper into the *Plasmodium spp*. landscape, our findings revealed that *P. falciparum* accounted for the entirety of cases, except for a singular incidence of *P. vivax*. Additionally, genotyping the Duffy domain rs2814778 mutation showcased a significant genetic diversity, with 59% of samples exhibiting Duffy-negative status, potentially influencing malaria susceptibility and transmission dynamics.

This study underscores the limitations of RDTs in detecting low-density parasite infections, posing challenges for malaria elimination efforts in DR. The detection of *P. vivax* raises concerns about relapse, emphasizing the necessity for innovative surveillance and disease management strategies. These findings contribute valuable insights to shape future malaria control approaches, steering efforts toward achieving the 2025 elimination goal and underscoring the significance of continued research endeavors in this critical domain.

NORADRENERGIC DEGENERATION IN A DJ-1 KNOCKOUT MOUSE MODEL

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Keywords: Parkinson's Disease, DJ-1, Noradrenaline

2030 Sustainable Development Goals: SDG3

Parkinson's disease (PD) is the second most common neurodegenerative disorder, with approximately 10% familial cases, caused by several identified mutations, such as in the DJ-1 gene. DJ1 knockout (KO) mouse models have been shown to present progressive motor behavioral deficits, without significant alterations in the nigrostriatal dopaminergic system, described as the neuropathological substrate of PD. Degeneration of the noradrenergic nucleus - locus coeruleus (LC) - has been linked to the development of non-motor symptoms and to the aggravation of motor symptoms.

We aimed to study the involvement of LC degeneration in a DJ-1 KO model looking at both motor and non-motor phenotype. For that, we have administered a selective noradrenergic neurotoxin (DSP-4) in DJ-1 KO mice. First, we optimized the appropriate dosage to be administered. To assess functional alterations, we have performed a battery of behavioral tests covering several symptoms associated with PD, including depression, anxiety, cognitive impairments, impaired locomotor activity and gait dysfunction. To assess the histological effects of both DSP-4 and the mutation we have performed Tyrosine Hydroxylase (TH) immunohistochemistry on the LC, substantia nigra (SNpc), and striatum (STR).

DJ-1 animals have shown tendencies to impaired motor functioning, gait dysfunction and a tendency to develop anxiety-related to novelty. DJ-1 KO treated with DSP-4 showed impaired swimming ability, gait dysfunction, tendency for depressive-like behavior, and improved fear memory retrieval. DJ-1 animals showed a reduction of 42.6% in striatal densitometry and a decrease in the number of TH+ cells in the SNpc compared to WT littermates. The injection of DSP-4 led to a decrease of 83-85% neurons within the LC. DSP-4 administration in DJ-1 mice led to a 58% decrease in dopaminergic fibers content in the striatum but did not affect nigral neurons.

In this work, we developed a model capable of recapitulating noradrenergic degeneration described in PD, which led to significant nigrostriatal degeneration, and was translated into mild behavioral phenotype, at the motor and non-motor level. This model may provide a suitable approach for the study of neuroprotective therapies focused on the LC noradrenergic neurons.

ITACONATE DEFICIENCY ENHANCES ANTI-FUNGAL EFFECTOR FUNCTIONS OF MACROPHAGES AND CONFERS RESISTANCE TO INFECTION WITH *ASPERGILLUS FUMIGATUS*

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Keywords: Aspergillosis, Itaconate, Immunometabolism.

2030 Sustainable Development Goals: SDG3, SDG9, SDG10

The success of cancer chemotherapy and solid organ and stem-cell transplantation has, paradoxically, increased the population of immunocompromised patients. These patients display extreme susceptibility to opportunistic life-threatening forms of fungal infections, such as invasive pulmonary aspergillosis (IPA), a devastating infection caused primarily by the fungal pathogen *Aspergillus fumigatus*. Over 30 million people worldwide are at risk of IPA, with >300,000 cases of infection reported each year. Its challenging diagnosis coupled to the absence of licensed vaccines and ineffectiveness of antifungal drugs have resulted in significant mortality and economic burden.

Dissecting the complex pathogenesis of IPA requires a molecular understanding of the physiological processes of antifungal immunity. It is known that, in response to infection, activated myeloid cells display enhanced expression of the immune-responsive gene 1 (IRG1), which encodes the aconitate decarboxylase 1 (ACOD1) that catalyzes the decarboxylation of the tricarboxylic acid cycle intermediate cis-aconitate to itaconate. Itaconate has been widely recognized by its immunoregulatory and antimicrobial properties and even though the precise mechanisms controlled by this metabolite are not fully clarified, its net-function is thought to be anti-inflammatory. Hence, we aimed to elucidate the contribution of ACOD1 function and itaconate to host defense against the opportunistic fungal pathogen *A. fumigatus*. We found that infection of bone marrow-derived macrophages (BMDMs) with *A. fumigatus* resulted in increased expression of *Acod1* and consequent itaconate production. Interestingly, BMDMs from *Acod1*$^{-/-}$ mice displayed an enhanced ability to phagocytose and eliminate conidia of *A. fumigatus* comparing to wild-type macrophages, a phenotype that was compromised when *Acod1*$^{-/-}$ macrophages were pre-treated with itaconate, highlighting a possible unexpected and detrimental role of itaconate during *A. fumigatus* infection. Since no differences were observed regarding the production of reactive oxygen species between macrophages of the two backgrounds, we are currently exploring a possible direct role of itaconate as a "virulence trigger" that leads to enhanced fungal germination and/or remodels the fungal cell wall. Of note, *A. fumigatus* exposed to different concentrations of itaconate displayed different patterns of germination in a dose dependent-manner.

Altogether, these results highlight a possible detrimental role of itaconate in antifungal immunity and shed light on a possible new mechanism involved in the pathogenesis of IPA.

EXPANSION OF INDUCED PLURIPOTENT STEM CELL-DERIVED MESENCHYMAL STEM CELLS USING A XENOGENEIC-FREE HUMAN PLATELET LYSATE AS GROWTH MEDIUM SUPPLEMENT

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Keywords: Fetal Bovine Serum; Human platelet lysate; Mesenchymal Stem Cells.

2030 Sustainable Development Goals: SDG9, SDG12

With the recent development of novel cell-based therapies for regenerative medicine there is an increased demand for growth medium supplements for stem cell culture. Although xenogeneic free alternatives are already available, Fetal Bovine Serum (FBS) is still the most commonly used growth medium supplement, with recent figures estimating that about 800,000 liters of FBS are produced annually worldwide, corresponding to 2,000,000 bovine fetuses. Human platelet lysate (hPL) is a viable replacement of FBS as a culture medium supplement for human stem cells, in line with the principles of the 3Rs for humane animal research. In addition, hPL can be manufactured from expired platelet units, contributing in this way to reduce the waste of this blood-derived product.

HPL has already been tested as an alternative to FBS in mesenchymal stem cells (MSCs) cultures, with improved cell performance widely reported. However, the use of hPL during manufacturing of human induced pluripotent stem cell (iPSC)-derived MSCs (iMSCs) has yet to be fully assessed.

This work aims to characterize human iMSCs expanded using standard hPL or xeno-free hPL (XF-hPL), contributing to the refinement of hPL formulations for iMSCs expansion.

Growth factor content of standard and XF-hPL was analyzed by Multiplex assays. iMSCs derived from three iPSC lines expanded in standard or XF-hPL. In vitro differentiation of iMSCs into adipocytes, chondrocytes and osteocytes was assessed by immunofluorescence staining of FabP4, aggrecan and osteocalcin (respectively). Immunophenotype was assessed by flow cytometry and the percentage of senescent cells was quantified by β-galactosidase staining; iMSC secretome was collected at passage 9 for analysis by membrane-based antibody array.

iMSCs expanded in culture medium supplemented with XF-hPL proliferated at a slightly lower rate compared to standard hPL (average of 31.0 and 34.5 cumulative population doublings, respectively). In addition, these cells exhibited *in vitro* trilineage differentiation, high expression of CD73/CD90 (> 95%) and low expression of CD45/HLA-DR (< 2%). The percentage of senescent cells remained below 10% up to passage 15. Secretome collected from XF-hPL -expanded iMSCs contained lower IL-8 and MCP-1 levels, compared to standard hPL.

The lower IL-8 and MCP-1 content in iMSCs secretome may improve its immunomodulatory capacity. This hypothesis will be tested in immunomodulation assays. Overall, the data presented here support the use of hPL for xeno-free expansion of human iMSCs towards manufacturing of cell-based therapies for regenerative medicine, as a more sustainable alternative to FBS.

OMEGA-SEC: PRIMING ADIPOSE-TISSUE MESENCHYMAL STEM CELLS SECRETOME WITH DOCOSAHEXAENOIC-ACID FOR REGENERATIVE MEDICINE APPLICATIONS IN THE CENTRAL NERVOUS SYSTEM

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Keywords: Mesenchymal stem cells secretome, Docosahexaenoic acid, Neurotrauma

2030 Sustainable Development Goals: SDG3, SDG8

Adipose-tissue derived mesenchymal stem cells (ASCs) secretome have been employed in several regenerative medicine paradigms. Emerging studies have demonstrated the feasibility of adopting molecular priming of ASCs with inflammatory cytokines as a strategy to improve their secretome molecular composition. In this work, a strategy inspired in the biology of the adipose tissue was employed, to prime ASCs to produce an improved secretome for central nervous system regenerative applications. By taking advantage of the specific expression of (free fatty-acid receptor) FFAR4 in their primary cilium, ASCs were treated with a natural FFAR4 ligand, the omega-3 fatty acid docosahexaenoic acid (DHA). Therefore, the aims of this work were to perform dose-escalation assays (1-50μM) to study the most suitable DHA dosage for priming as well as to characterize the impact of DHA on several aspects of ASCs biology and secretome performance on neuronal in vitro systems. Results demonstrated that metabolic viability was 25% higher in groups treated with (10, 25 or 40μM) after 72h exposure. Evaluation of cellular morphology showed a high stability throughout the dose and time range. A transcriptional analysis of down-stream FFAR4 target engagement revealed 40μM to be the most potent in engaging the receptor prompting us to choose it for further studies. Additionally, DHA treatment had a small but significant effect on modulating mitochondrial dynamics, with gene expression and 3D image analysis revealing an induction in mitochondrial fission over time. Importantly mitochondrial membrane potential was increased in DHA treated cells indicating increased mitochondrial activity. Proliferation and senescence features demonstrated that DHA reduces ASCs proliferation without affecting hallmarks of senescence over multiple passages. Importantly, this reduction in proliferation was due to an increase in the doubling time of cells rather than by the induction of apoptosis. An initial secretome analysis demonstrated that treated cells produced secretomes with 60% more protein content, which we termed ω-sec. When tested functionally in a human neural progenitor cell culture system, ω-sec increased the percentage of undifferentiated cells in spite of having identical levels of differentiated cells when compared to control secretome. In a mixed-cells spinal cord culture system, ω-sec induced higher cellular protection from an osmotic shock paradigm when compared to control secretome. This work demonstrates that DHA have positive effects on the metabolism of ASCs that correlated to functional enhancement of their secretome, which is demonstrated by induction of neurodifferentiation, as well as neural and glial protection in vitro.

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STUDY OF THE PROCESSING AND PROPERTIES OF NITRILE RUBBER (NBR) WITH RESIDUES FROM FLEXIBLE POLYURETHANE (PU) FOAMS

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Keywords: Solid Waste Management, Footwear Industry Sustainability.

2030 Sustainable Development Goals: SDG12

The management of a large amount of solid waste is one of the major contemporary issues, with a significant contribution from polymeric waste generated by various industrial sectors. Two factors that have contributed to the increasing volume of polymeric materials disposed of as waste are their widespread use due to cost and technological versatility, and the difficulties associated with the decomposition of these materials. Therefore, it is of great interest to seek solutions that aim at the utilization of materials that are traditionally treated as waste, contributing to the reduction of environmental impacts associated with industrial activities.

The footwear industry is one of the examples of industrial sectors that generates this type of waste. In recent years, it has undergone a significant transformation as sustainability becomes a fundamental pillar. Aware of the environmental and social impacts associated with large-scale production, footwear manufacturers are adopting more responsible practices to ensure that every step in the production chain is eco-friendly.

The main objective of this project is to study the feasibility of processing nitrile rubber soles with polyurethane waste. To validate this approach, it is crucial to assess technical aspects, such as mechanical strength. By incorporating these waste materials into the production of rubber soles, it not only reduces the environmental impact associated with waste but also creates an opportunity for the footwear industry to contribute positively to the circular economy.

It was necessary to carry out the mixing and vulcanization process of rubber according to a formulation with different percentages of polyurethane waste. Subsequently, flexing, abrasion, and tearing tests were conducted according to the standards and minimum requirements of the footwear industry for elastomers.

Based on the results obtained, it was possible to conclude that polyurethane exhibits a reinforcing character in the polymeric matrix. The mechanical tests were mostly positive, making it feasible to adjust the formulation for the use in sole processing.

The use of polyurethanes as reinforcing filler represents a study and application of great importance, allowing for the redirection of a material that poses environmental and waste problems as an alternative for improving physical properties when mixed with elastomers.

COMPOSITE FIBERS WITH HIGH LIGNIN CONTENT AS PRECURSORS FOR CARBON FIBERS

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Keywords: Lignin, Polymer composite, Carbon fiber

2030 Sustainable Development Goals: SDG8, SDG15, SDG17

Lignin is the second most abundant carbon-based material in nature, and is a residue produced in large scale by the pulp and paper industry. The chemical structure of lignin is complex, rich in aromatic macromolecules based on the reaction of three monolignols, originating different functional groups, isomers and chirality, variations in molecular weight, presence of rigid and soft molecular chain segments, impurities, that hampers the prediction of lignin properties. The highly aromatic nature of lignin makes it a potential source for graphite-based materials such as carbon fibres.

The objective of this work is to characterize a softwood lignin in terms of its chemistry and thermal properties, to produce composite fibres with high lignin content and a recycled polymer, and to study the fibre thermal stabilization process, in order to evaluate its potential for further production of carbon fibres.

Two polymers were selected for this study, namely glycol-modified polyethylene terephthalate (PET-G) and a blend of polycarbonate with acrylonitrile-butadiene-styrene (PC/ABS). Softwood lignin was acquired from West Fraser, Canada. The polymers were mixed with lignin at high lignin contents (50-60 wt.%) by melt mixing using twin screw extrusion. Composite filaments were produced and characterized by Infrared and Raman spectroscopies, as well as mechanical testing by dynamic mechanical analysis (DMA). The filaments were tested as produced and after thermal stabilization, carried out in air under tension.

Spectroscopic analysis showed that, typically above 250 °C, the chemical nature and physical structure of the lignin-rich composite fibres begin to change, increasing the aromatic content. The mechanical properties such as the storage modulus increased after the thermal stabilization process.

In conclusion, the proposed strategy is interesting for the production of high lignin content filaments with potential for further thermal treatment and formation of carbon fibres. Further studies will focus the maximization of the lignin content in the precursor fibres, and the use of recycled plastics such as ABS.

USE OF CIRCULARITY MICRO-LEVEL INDICATORS IN THE DEVELOPING PROCESS OF PLASTIC PARTS FOR THE AUTOMOTIVE INDUSTRY

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Keywords: Circular Economy; Micro-level Indicators; Plastics in Automotive Industry

2030 Sustainable Development Goals: SDG9, SDG12, SDG13, SDG15, SDG17

Plastics have brought many advantages to the automotive sector. However, the complex design of parts, the variety of polymers used and the presence of hazardous additives, hampers its separation, reuse, or recovery at the vehicle's end of life (EoL). An increase of plastics in automotive shredder residues (ASR) is observed, making it important and urgent to reuse and recover the plastics. The aim is the transition towards a more circular economic model.

At the moment there are no standard methods to assess circularity. The scientific community has proposed a myriad of tools, such as the circularity indicators. They range widely in complexity, philosophy, method of calculation, and type of required information. They mostly focus on some aspects of the entire product life cycle.

In this work, the most relevant micro-level circularity indicators for automotive industry were identified, namely, recycling desirability indicator (RDI), the material circularity indicator (MCI), the value-based resource efficiency indicator (VRE), the material reutilization score (MRS), and the disassembly effort index (DEI). They were further applied to several plastics components as examples of case studies of the automotive industry (tier II suppliers). Attempts to adjust and redesign the current cycle in the product development process were made. In addition to the existing inputs such as marketing and technical specifications, aspects of circularity and sustainability were also considered.

It was concluded that the evolution over the years of the automotive industry towards multi-component, multi-material products, and coupling of parts by welding, has made the plastic parts more difficult to reuse, repair, and recycle. The low number of recycled materials incorporated in the plastic parts, and the lack of materials collected to recover their value at EoL, results in plastics automotive parts with considerably low levels of circularity. Therefore, the use of micro-indicators at early stages of the product development helps the designers to identify several opportunities for improving the circularity of plastic products.

With the methodology adopted for the circularity of plastics we contribute for the progress of the circular economy at the industrial level, by removing the barriers currently existing and providing to the industry the ability to inform their customers of the circularity level of their products.

MAGNETICALLY TRIGGERED SHAPE DEFORMATION OF POLYURETHANE COMPOSITES

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Keywords: Shape-memory polymers, Magnetic particles, Thermoplastic polyurethane

2030 Sustainable Development Goals: SDG9

Granting magnetic properties to rubbery polymers opens possibilities to generate smart materials for multiple applications, allowing reversible deformations under a magnetic external stimulus. Magnetic responsive shape-memory polymer composites can be designed at low magnetic particle content to enable remote actuation, achieving shape deformation by inductive heating or magnetorheological effects.

Commercial (Sigma-Aldrich) and sol-gel synthesized Yttrium-Iron Garnet (YIG, $Y_3Fe_5O_{12}$) nanopowder (NP) as described in the literature were characterised before and after calcination at 1000 °C. Thermoplastic polyurethane (TPU) composites with loads from 5 to 40 wt.% of calcined commercial YIG were produced by compression moulding. Their shape-memory ability was tested under a magnetic field.

Thermal treatment of YIG NP (3h at 1000ºC) modified the structure of commercial and sol-gel synthesized (pH 10) YIG NP, increasing the saturation magnetization of the particles. All TPU/YIG composites display a magnetic response that increases with YIG content. Shape-memory behavior, triggered by a magnetic field of 500 G, was observed for all the composites with calcined and sol-gel synthesized YIG.

A simple method was used to produce composites with YIG particles, that display magnetic response at low particle loading. Such composites respond to a magnetic field, displaying a shape-memory behavior, and can be used as soft actuators, for example, in soft robotics.

STUDY OF ORGANOLEPTIC ADDITIVES AND INSECT REPELLENTS FOR POST-CONSUMER RECYCLED POLYOLEFINS

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Keywords: Post-consumer recycled materials, Rotational molding, Organoleptic

2030 Sustainable Development Goals: SDG12

Post-consumer recycled (PCR) materials are becoming available for the substitution of virgin plastic materials. They are a viable alternative solution for increasing their circularity. The recycling process may reduce the overall properties of the plastics and the final product may exhibit undesirable odors. Therefore, this research evaluates the processing and properties of post-consumer recycled polyethylene with aromatic additives to deliver active insect repellency and fragrance in products made by rotational molding. This technique is known for the manufacturing of hollow parts through a slow process at high temperatures in an oxidative atmosphere. Therefore, it's important to evaluate the properties of both the polymeric matrix and additives, as they must remain stable under such conditions.

This study aims to produce parts made from recycled polymer matrix impregnated with fragrance additives, in solid and liquid states. The polymeric matrix used was Sirblend R 00 040 CS AX, provided by SIRPLASTE (Porto de Mós, Portugal), a recycled high-density polyethylene (HDPE) in powder form, whereas the additives were citronella oil, cinnamon powder, and laurel powder. The investigation focused on the effect of the additives on PCR-HDPE, its processing characteristics, and also on the morphological and mechanical properties of the parts. A mixture containing 3% by mass of the additive was used for this purpose.

Pristine and compounded materials were characterized by granulometry, dry flow, apparent density, melt flow index (MFI), differential scanning calorimetry (DSC), thermogravimetric analysis (TGA) and Fourier Transform Infrared Spectroscopy (FTIR). The incorporation of additives did not cause significant changes in melting and crystallization temperatures, implying that their presence does not influence the structural organization of the polymer matrix. The MFI results indicated a plasticizing effect of the oil. Furthermore, its addition reduced the apparent density and hindered the dry flow; that was attributed to the polymer's humidification. Despite of that, the direct introduction of oil improved the surface finish of the part, reducing the occurrence of surface pinholes. In the case of powdered additives, pinholes were abundant, as well as voids on the part. The citronella, cinnamon and laurel fragrances were well present in the parts after processing.

DEVELOPMENT OF ECO-SUSTAINABLE COMPOSITE SANDWICH STRUCTURAL PANELS

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Keywords: Eco-sustainable, Sandwich structure, Composites

2030 Sustainable Development Goals: SDG9, SDG12

The paper discusses the development of an eco-sustainable composite sandwich structure that presents good physical and mechanical properties. This type of structures has applications in various areas, from construction to railways, where materials with a high strength-to-weight ratio are required. Currently, the materials most used in the construction of these structures are based on thermosetting resins, polyurethane foams, and polystyrene, among others. Although these materials perform well mechanically, they are not eco-sustainable and cannot be reused after their lifespan. To overcome this limitation, we investigate the feasibility of replacing conventional materials used in the construction of sandwich structures with eco-sustainable materials. To achieve this goal, the project has specific stages: 1) produce a prototype sandwich panel through hot compression techniques; 2) develop a honeycomb core with proprietary technology that allows the manufacture of a highly rigid composite structure; 3) characterize the mechanical and physical properties of the sandwich composite structure to ensure its technical viability.

The obtained prototype was made of thermoplastic resin and bio-based reinforced fibers. Additional evaluation tests are suggested to confirm the mechanical and thermal properties, including low-velocity impact resistance, compressive strength, thermal insulation, flammability, and other relevant properties. Thus, it is expected to provide the industry with the opportunity to substitute conventional sandwich panel structures with environmentally friendlier alternatives.

CALCULATING THE CARBON FOOTPRINT OF PLASTIC PARTS

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Keywords: Greenhouse Gas Emissions, Carbon Footprint, Environment Management, Plastics

2030 Sustainable Development Goals: SDG9, SDG12, SDG13

This abstract provides insights on the importance of calculating the Carbon Footprint of plastic parts and how this calculation can be of benefit to the automotive industry. The aim of this work is to calculate the Carbon Footprint of a decorative plastic part for the automotive industry. The part consists on an injection moulded part made of PC/ABS and a TPS stopper, which is then painted with a high-gloss paint. A steel spring is attached to the part after paining. The work enables a detailed assessment of the part's life cycle, providing a comprehensive overview of the environmental implications of this product, as well as identifying opportunities for reducing emissions throughout the production chain.

The review begins by elucidating the fundamental principles of the production processes of the product under study, the Carbon Footprint, the methodologies to be considered for calculating the Carbon Footprint and the various possible approaches to specify the life cycle of a product.

All the activities necessary for the production of the parts were first established. They consisted briefly on the injection mould of the parts, painting of the PC/ABS part, moulting the TPS stopper and finally assemble the steel spring. The necessary data such as energy power consumption, emission factors and allocation factors were further collected.

The Carbon Footprint value was obtained by adding up the Carbon Footprint of all the life cycle stages, which is obtained by multiplying the emission factor by the consumption. If the stage is related to transport, it is also multiplied by the allocation factor.

It was concluded that painting of the part and transportation of the product to the client (buyer) where the most relevant steps for greenhouse gases emission. The painting process has a higher percentage of scrap and large quantities of GHG are emitted resulting from that. The transport of the product to the buyer is also important, since the GHG emissions do not depend exclusively on the company. This highlighted the need to involve the supply chain in an effort to reduce the carbon footprint and to apply this metric to other products.

PROCESSING AND CHARACTERIZATION OF POST-CONSUMER RECYCLED MATERIALS FOR ROTATIONAL MOULDING APPLICATIONS

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Keywords: Post-consumer recycled (PCR) polymers, Rotational moulding, polymer properties

2030 Sustainable Development Goals: SDG12

The circular economy has become an increasingly unavoidable issue for the plastics processing industry. The mechanical recycling of thermoplastic polymers is a good opportunity to address this matter and to reduce the consumption of virgin raw materials and to obtain products at very low costs. This work belongs to an ongoing study into the use of post-consumer recycled (PCR) polymers, predominantly consisting of recycled high-density polyethylene (HDPE)r, provided by SIRPLASTE company (Portugal) in powder form for rotational molding applications. This processing technique is typically used to produce large hollow, rigid and resilient structures, like tanks, kayaks, leisure furniture, etc. The study includes a comprehensive analysis of the material in terms of its composition, thermal and physical characteristics by means of Fourier Transform Infrared Spectroscopy (FTIR), Differential Scanning Calorimetry (DSC), Melt flow Index (MFI), apparent density, dry flow and granulometry and also processing and characterization of parts. The results identified a HDPE material with a small fraction of Polypropylene (PP). The powder quality analysis revealed a dry flow time and granulometry of recycled HDPE slightly lower than that designed for rotational molding, which may indicate possible challenges in its flow during rotational molding. Its implications may be observed on the thickness distribution, the appearance of surface pinholes and also voids on the part. The processability of HDPEr revealed the presence of pin-holes at the surface, indicating insufficient sintering of the material during the processing cycle. Although increasing the mass and temperature inside the mold reduced these defects, there was an increase in warping and distortion of the parts. The study has shown that HDPEr is indeed viable for rotational molding process. The work is under way to improve the quality of the parts and to reduce its defects through, for example, its mixture with virgin materials, and optimization of processing conditions.

STUDIES ON THE REPROCESSING OF POLYETHYLENE AND POLYPROPYLENE BLENDS

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Keywords: Polyolephins, Blends, Recycling

2030 Sustainable Development Goals: SDG8, SDG9, SDG12, SDG13, SDG17

Polypropylene (PP) and polyethylene (PE) dominate plastic packaging. Their mechanical recycling is used to recover materials. However, given its similarities in density, they are difficult to separate in the stream lines. The mixtures of materials with different rheological characteristics is also frequent and unavoidable. This study explores the properties of virgin and reprocessed PE/PP blends with strong difference in melt flow index. Extrusion-blown high-density polyethylene (HDPE PCG863 from SABIC, MFI 0.35g/10 min, 190°C/2.16 kg) and PP injection moulded grade (ISPLEN PP080G2M by Repsol, MFI 20g/10 min, 230°C/2.16 kg), were mixed at varying weight percentages (0, 20, 40, 60, 80, and 100% of PP into HDPE matrix) and further processed by injection moulded to produce small tensile specimens. They were characterized for their thermal, mechanical and morphological properties. The increase of PP into HDPE increased the melt flow index (MFI) of the blends. Differential scanning calorimetry revealed two peaks corresponding to the HDPE and PP. Melting temperatures were consistent across all blends. A slight rise in the degree of crystallinity for PP and a minor decrease for PE was observed when PP content increase on the blend. A typical skin-core structure, with a very thin skin, elongated spherulites in the sub-skin region and small spherulites in the core was obtained. Virgin or reprocessed blends showed similar microstructures. SEM images show no visible phase separation between polymers but reveal a transition in fracture surface around HDPE/40% to 60% PP, from grooved surface typical of HDPE to smooth fracture surface of PP. Tensile behaviour varies significantly according to the content of the blend: both materials are ductile, however PP exhibits much higher ductility than HDPE. Therefore, the increase content of PP on the blend enhances the blend's Young modulus and elongation at break. Polyolefins were successfully blended and reprocessed, exhibiting slight variations in properties based on composition. Reprocessed blends generally show up to a 20% reduction in properties compared to virgin counterparts due to the additional processing step. This topic is relevant to guide companies on the reprocessing of their own materials and blend and for understanding mechanical recycling of polyolefin waste streams.

CIRCULARITY THROUGH RECYCLING OF THERMOPLASTIC MATRIX COMPOSITES

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Keywords: Composites, Recycling, Circularity

2030 Sustainable Development Goals: SDG9, SDG12, SDG13

Continuous fiber composites with a thermosetting matrix exhibit excellent chemical and mechanical resistance due to the matrix crosslinking process and the structural reinforcement of the fibers, respectively. However, this crosslinking process is irreversible, preventing the fusion of the matrix for reprocessing and recycling, thus hindering material circularity. To avoid the end-of-life disposal of these materials in landfills or their reuse as fillers for lower-value components, liquid thermoplastic matrices have emerged for the processing of continuous fiber composite materials using conventional composite material production methods (e.g., RTM, vacuum-assisted infusion, hot compression). Thus, the main objective was to verify if recycling of this material was possible.

To validate the process, a laminate consisting of carbon fibers and ELIUM 188 XO liquid thermoplastic resin, composed of polymethyl methacrylate, was initially produced through the vacuum-assisted resin infusion process. To facilitate mechanical recycling, the initial laminate was cut into smaller squares and subsequently subjected to a milling machine. Once all the crushed material, which exhibited a highly heterogeneous particle size distribution, was obtained, it was sieved to separate the different fiber sizes. To analyze the material properties based on the fiber size distribution, each sample's material was then hot compressed. Finally, flexural tests were performed on the initial material and the recycled material plate, DSC and FTIR tests were conducted on the initial laminate, crushed material, and the compressed plate of recycled material, and densities were calculated and compared. It was observed a decrease in mechanical properties of the composite material with the reduction in fiber size, as expected, it remained usable, unlike thermosetting matrix composites. However, it is crucial to consider that these properties depend on the particle size. Larger particle sizes, associated with higher fiber lengths, limitate the material reprocessing and compaction, compromising its properties negatively.

With this study, the validation of this circularity process was achieved, confirming the possibility of utilizing thermoplastic matrix composite materials through mechanical recycling processes and subsequent hot compression moulding techniques.

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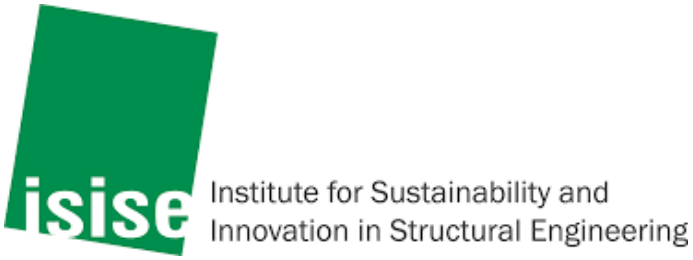

ADAPTATION OF TRADITIONAL RISK-BASED METHODOLOGY FOR SLOPES TO PROBABILISTIC-BASED APPROACH INTEGRATING SURROGATE MODELS

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Keywords: Risk analysis, Seismic fragility curves, Parametric analysis, Railway systems, Surrogate models

Due to the economic importance that railways systems have in Europe, it is pertinent to ensure good performance and long-term safety. Failure of earth structures (e.g., slopes) often results in major economic consequences, and it is a result of the uncertainties associated with these structures and their failure modes due to a given hazard. Nowadays, different methodologies can be used to assess slopes during operational phases, but often the required information to achieve a reliable assessment may provide the methodologies inapplicable, especially when assessing multiple assets. This research uses methodologies that have been implemented in the industry and adapts them to a probabilistic approach toward risk assessment, supported by the implementation of kriging surrogate model, thus improving its reliability while maintaining the same level of information and computational cost required for its application. A soil cutting located in the Lisbon (Portugal) was selected as case study. Seismic fragility curves are obtained, and a moderate risk level is obtained. The derived fragility curves are based on peak ground acceleration and were developed for different combinations of geometric and geotechnical parameters. The methodology provides useful information for prioritizing assets and taking preventive actions to maintain the desired performance of the railway system.

DEVELOPMENT OF AN ECOLOGICAL THERMAL INSULATION PRODUCT FOR A REGENERATIVE BUILDING DESIGN

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Keywords: Bio-based insulation, Regenerative design, Low-carbon construction

2030 Sustainable Development Goals: SDG11, SDG13, SDG15

This research aims to investigate invasive plant species in Portugal to develop a bio-based thermal insulation product for buildings. Currently, in the European Union, buildings account for nearly 40% of energy consumption, a third of greenhouse gas (GHG) emissions and approximately 50% of all extracted materials. While insulation products are crucial in reducing energy demand, commonly used materials often have high embodied energy. Bio-based thermal insulation products, however, sequester carbon and exhibit lower embodied energy.

On the other hand, using invasive species biomass allows controlling their spread and establishes a value chain for this resource. This work intends to characterise the Cortaderia selloana reed, also known as pampa grass, to understand its possibilities as an insulation material.

The primary objectives include developing and examining manufacturing processes for insulation panels in compliance with regulatory requirements: one utilising the entire culm sections and another employing waste from the first in a crushed reed agglomerate. The study also aims to analyse the environmental and economic life cycle performance of the new insulation products, comparing them with conventional counterparts. Furthermore, it aspires to contribute to a circular economy by creating low environmental impact, minimally processed, cost-effective, and biodegradable products.

Research methods are based on the experimental characterisation of the new insulation products, to evaluate if they fulfil specific construction requirements, and life cycle assessment of environmental impact. Results indicate a significant advantage of fast-growing bio-based materials in terms of environmental impact due to their biogenic carbon content. Additionally, thermal analysis reveals that reed panels exhibit performance comparable to cork as insulation products, possibly attributed to internal structures with voids trapping air.

Overall, the research highlights the potential of bio-based insulation materials, particularly those derived from fast-growing and invasive species. The developed material not only promotes sustainable development but also contributes to biodiversity preservation by aiding in species control and maintaining native lands. This research plays a vital role in advancing sustainable and resilient building sector.

STRATEGIES AND ACTIONS FOR ACHIEVING CARBON NEUTRALITY IN PORTUGUESE RESIDENTIAL BUILDINGS BY 2050

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Keywords: Building energy renovation, Carbon taxes, Carbon neutrality

2030 Sustainable Development Goals: SDG7, SDG13, SDG17

As a crucial step in addressing the climate emergency and enhancing energy security, the European Union has set ambitious targets to decarbonise its economy by 2050. While the building sector plays a pivotal role in this transition, being accountable for 36% of the EU's total carbon emissions, it shows a renovation rate below 1% per year, which is clearly insufficient. To address this challenge, this study uses the cost-optimal methodology from private and social perspectives to assess the cost-effectiveness and environmental impact of five renovation packages with passive and active solutions currently available on the Portuguese market. The results demonstrated that from both perspectives, optimal combinations of market solutions were generally cost-effective and could lead to a 90-99% reduction in energy needs and even to zero carbon levels. Nevertheless, beyond cost-effectiveness, consideration of co-benefits covering, e.g., social and health improvements, is also crucial, requiring government action. To drive these essential changes, effective policy measures are imperative. Recommendations encompass robust regulatory frameworks, financial support mechanisms, knowledge dissemination, and a shift towards broader-scale renovation. For carbon reduction to be economically attractive, fostering innovative business models and leveraging legal instruments to tackle complex scenarios are needed.

Published in *Sustainability15*(21), 15626, 2023 (https://doi.org/10.3390/su152115626).

ANALYZING THE FEASIBILITY OF INTEGRATING URBAN SUSTAINABILITY ASSESSMENT INDICATORS WITH CITY INFORMATION MODELLING (CIM)

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Keywords: City information modelling, Urban sustainability assessment methods, Urban sustainability indicators

2030 Sustainable Development Goals: SDG11

Sustainability assessment methods have gained the attention of urban planners and policymakers since they promote a comprehensive view of the cities. Intelligent solutions, enabled by advances in information technologies, can accelerate progress in achieving sustainability goals. In this context, City Information Modelling (CIM) emerges as a tool to facilitate urban sustainability assessment implementation. Accordingly, the main question aimed to address in this article is whether conventional sustainability assessment tools can be adapted to the CIM framework. In this regard, this study extracts the most consensual list of indicators from four sustainability assessment methods: BREEAM-C, LEED-ND, SNTool, and SBToolPT Urban, to identify a clear set of key sustainability priorities. The selected sustainability assessment methods are pioneering and often used for performance assessment at the urban scale. Furthermore, the indicators extracted from the assessment methods are measurable and can present accurate results. The study analyses the potential of the selected indicators to be calculated in CIM. The final product of the article is identifying the indicators that are adaptable to be used in the CIM approach.

Published in *Applied System Innovation* 6(29, 45, 2023 (https://doi.org/10.3390/asi6020045)

DEVELOPMENT OF OPTIMISED COMPRESSED EARTH BLOCKS BY USING MATERIALS OF NATURAL ORIGIN

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Keywords: Compressed earth blocks, Optimisation, Sustainable construction product

2030 Sustainable Development Goals: SDG11, SDG13

As a building material, earth holds promise in meeting contemporary sustainability criteria. The raw material can be sourced with minimal environmental and economic impact than traditional materials. At the end of its life cycle, it can be reused or returned to the natural environment. It offers commendable hygroscopicity, enhancing indoor air quality and overall healthiness. With a rich construction tradition, earth also carries a unique identity as a building material. Compressed Earth Blocks (CEBs) emerge as a leading solution for modern applications among the available construction techniques. If necessary, these unfired masonry blocks, composed of a mixture of earth, water, and a stabiliser, are produced by compression with manual or hydraulic presses. CEBs exhibit an estimated 80% reduction in carbon dioxide emissions compared to conventional fired clay bricks. As a result, research in this field is thriving and unanimously underlines the enormous potential inherent in this building material.

This research project focuses on enhancing the thermal performance of CEBs. The proposed strategy involves exploiting the properties of selected natural materials and prioritising waste and by-products to foster circular approaches and innovative waste disposal methods. This approach not only maintains the inherent sustainability of the blocks but also contributes to cost-effectiveness and establishes a virtuous local supply chain by assigning new value to waste materials. The critical research question concerns the possibility of improving the thermophysical properties of CEBs using selected natural materials without compromising mechanical strength and durability while keeping environmental impact and costs low.

Using Portuguese agricultural and industrial products, the chosen natural materials were wheat straw fibres, cork granules sourced from bottle stoppers, and ground olive stones derived from olive oil production. A comprehensive set of experimental and analytical methods was implemented to achieve the research objective, encompassing critical thermophysical, mechanical, and durability properties. An extensive experimental campaign was conducted on ten distinct blends, examining over 300 blocks. Experimental investigations were further completed by microstructural insights, still rare in the field of building materials, but essential to unveil hidden mechanisms. Significant advancements were observed by replacing soil with 5% cork and 15% olive kernels, resulting in a substantial 25% and 35% improvement in thermal resistance, respectively. Results show that this substitution enhanced performance and contributed to preserving natural soil resources.

ADVANCING SUSTAINABLE INFRASTRUCTURE ASSESSMENT: GROUND PENETRATING RADAR (GPR) FOR NON-DESTRUCTIVE EVALUATION OF ASPHALT PAVEMENTS

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Keywords: Ground-Penetrating Radar (GPR), Sustainable Infrastructure Assessment, Non-Destructive Pavement Evaluation

2030 Sustainable Development Goals: SDG9, SDG11, SDG15

This abstract underscore the significance of Ground Penetrating Radar (GPR) as an innovative and sustainable tool for the non-destructive evaluation of asphalt pavements. GPR plays a pivotal role in constructing resilient infrastructures by enabling early defect identification and fostering proactive interventions. Moreover, it promotes operational efficiency and sustainability in highway maintenance. In the urban context, GPR facilitates safe and inclusive urban planning, averting structural failures, and fostering long-term resilience and sustainability. The non-destructive approach of GPR also plays an essential role in safeguarding terrestrial ecosystems, mitigating environmental degradation, and contributing to the responsible use of natural resources in road management.

This study employed an innovative approach utilizing Ground Penetrating Radar (GPR) as a non-destructive technique to assess asphalt pavements. We manufactured asphalt mixture slabs to simulate pavements, conducted GPR tests to visualize the internal structure, and stored the data for analysis in ReflexW software, generating radargrams. This efficient methodology facilitated the acquisition of precise information on the structural condition of pavements, emphasizing the value of GPR as a valuable and sustainable tool in infrastructure assessment.

The results of applying Ground Penetrating Radar (GPR) highlight its remarkable efficacy in identifying defects and delamination in asphalt layers. Processed radargrams revealed the depth of layers and the presence of irregularities, providing valuable insights into the structural condition. Furthermore, GPR demonstrated its ability to map pavement compaction and identify areas with irregularities. This approach not only enhances predictive maintenance but also drives sustainability, reducing the need for frequent and costly interventions.

In the face of challenges posed by Sustainable Development Goals (SDGs), the application of GPR in asphalt pavements emerges as an innovative and sustainable solution. Conducting non-destructive assessments not only saves resources, time, and costs but also directly contributes to building resilient infrastructures and promoting sustainable industrialization. By making cities safer and more sustainable, this approach strengthens efforts to protect terrestrial ecosystems, combat desertification, and preserve biodiversity. In summary, the integration of Ground Penetrating Radar (GPR) represents a significant advancement toward achieving SDGs, emphasizing the importance of technological innovation in addressing contemporary challenges.

LABORATÓRIO DE INSTRUMENTAÇÃO E FÍSICA EXPERIMENTAL DE PARTÍCULAS

LABORATORY OF INSTRUMENTATION AND EXPERIMENTAL PARTICLE PHYSICS

LIP

APPLICATION OF QUANTUM COMPUTING TO QUANTUM CHROMODYNAMICS

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Keywords: Quantum Computing, Quantum Simulation, Particle Physics

2030 Sustainable Development Goals: SDG4, SDG8, SDG17

In the realm of particle physics, the quark-gluon plasma appears as a hot soup of quarks, which are fundamental particles, and gluons, which are the strong interaction force carriers. This soup existed in the initial microseconds of the universe, and so, knowing their properties enlightens us about the origins of the universe. Even though the quark-gluon plasma can be created in a laboratory, due to its short lifetime, the study of its properties requires the use of probes.

Jets, which are formed at the time of the creation of the quark-gluon plasma and have their properties modified by the interaction with the medium, are one of the most common probes to study the quark-gluon plasma. Due to the complexity of the jets' structure, the study of its dynamics is not a trivial task, and so, new techniques to simulate it have been proposed in the last decades. In this context, quantum computing emerges as a promising tool for the exploration of quantum chromodynamics, particularly in understanding the dynamics of jets.

Due to the fact that the current quantum devices have limited access and suffer from noise, this work is focused on the simulation of the dynamics of a parton, i.e. a quark or a gluon, in the quark-gluon plasma background field. The evolution of a parton in a QGP medium is a building block of the evolution of a jet in the medium, and so, this work stands as a precursor of the simulation of a jet in a quantum computer.

This work includes the presentation of the theoretical foundations of the propagation of a quark in a quark-gluon plasma medium, which serves as the root of the quantum simulation and the basis of the classical method to which the quantum algorithms are compared. Starting from the basics of quantum computing, the quantum circuits to simulate the target dynamics are designed and explained.

The projected quantum circuits are executed in quantum simulators and the retrieved results are analysed and compared with the classical ones. Although for this simple model there is a classical solution, for larger and more complex systems the classical solution doesn't exist. Consequently, beyond achieving the intended physical results, the significance of this work lies in establishing the potential use of quantum computers for investigating quantum chromodynamics properties, such as the simulation of jets.

ANOMALY DETECTION: A TOOL TO FIND NEW PHYSICS

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Keywords: Anomaly Detection, Particle Physics, New Phenomena

2030 Sustainable Development Goals: SDG4, SDG8, SDG9

The Standard Model (SM) of particle physics describes the fundamental constituents of visible matter successfully. Multiple experimental results validate the theory. However, there are certain phenomena like the existence of dark matter (DM) that are not explained by the SM. This discrepancy motivates the search for new physics. At the Large Hadron Collider (LHC), an expansive program is dedicated to these searches, characterised by the exploration of specific signals and event topologies.

Machine learning (ML) has become a tool across diverse scientific domains, and Particle Physics stands as a prime example of its extensive application. Over the past several years, ML has played an important role in increasing analysis sensitivity at particle colliders. Common algorithms such as Gradient Boosted Decision Trees (GBDTs) and Neural Networks (NN) have been the go-to choices in this field. However, the spotlight is increasingly turning towards Anomaly Detection (AD). Typically, AD is employed to identify anomalies that deviate significantly from established patterns.

In particle physics, AD emerges as a tool to explore collider data without making assumptions about the nature of new physics phenomena. By learning to reconstruct Standard Model (SM) events effectively, the AD algorithm becomes a sensitive detector of deviations, thereby offering a promising tool for the identification of new physics signals.

This study goes into a comprehensive examination of autoencoder architectures, a subset of AD methodology. The primary objective is to find the intricate relationships between different architectural parameters and their influence on the sensitivity to new signals. By scrutinizing the inner workings of autoencoders, this research seeks to advance our understanding of how these algorithms can be optimized for the nuanced task of uncovering new physics phenomena in the rich and complex datasets produced by particle colliders.

USING MACHINE LEARNING AND ARTIFICIAL INTELLIGENCE TO SCAN BEYOND THE STANDARD MODEL PARAMETER SPACES IN PARTICLE PHYSICS

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Keywords: Particle Physics, Artificial Intelligence, Parameter Spaces

2030 Sustainable Development Goals: SDG4, SDG8, SDG9

The Standard Model (SM) of particle physics describes the fundamental particles and forces in our universe and is the most successful theoretical ground available for particle physicists. However, there are still several uncharted territories to explore that remain unexplained by the SM. Among those, the existence of dark matter (DM) and neutrino masses, which demand explanations which go Beyond the Standard Model (BSM) scope.

When trying to come up with solutions to these problems, physicists, in general, propose new BSM theories which often employ a vast number of free parameters. In order to assess the validity of such theories, it is necessary to confront their predictions with the available experimental data. However, due to the large number of free parameters and experimental results, this task is typically computationally intensive and time consuming.

We propose a solution to this problem by adopting sampling algorithms which make use of Machine Learning methods in order to improve the efficiency of this validation task. The efficiency and exploratory capacity of these algorithms were tested using the parameter space of supersymmetric models and constrained experimentally by the Higgs mass and the Dark Matter relic density. The results show a massive improvement in efficiency with only minor sacrifices in parameter space coverage.

LABORATÓRIO DE PAISAGENS, PATRIMÓNIO E TERRITÓRIO

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ANADROMOUS SEASCAPES: UNDERSTANDING MARINE SPATIAL USAGE IN TACKLING THE IMPACT OF URBAN INFRASTRUCTURE ON MIGRATORY SPECIES.

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Keywords: Human-environment interactions, Marine urbanization, Anadromous fishes

2030 Sustainable Development Goals: SDG14, SDG11

This work explores the potential impact of a marine infrastructure on migratory marine species and human-environment interactions. It emphasizes the importance of understanding the spatial usage of the marine territory, which includes not only nearshore and offshore areas but also brackish water and freshwater areas such as river mouths, estuaries, and bays. It is suggested that such an understanding is crucial for managing the externalities brought by the infrastructure and for mitigating its impact on marine fauna.

The investigation follows an inductive approach as some authors argue that findings derived from particular cases are capable of supporting the elaboration of generalizations (Marconi, 1993; Gil, 1999). To conduct this study, three case studies were analysed: the Offshore Wind Park along the coast of Viana do Castelo in Portugal, the Afsluitdijk dike between the Wadden Sea and the former Southern Sea estuary in the Netherlands, and the Port of Suape in Northern Brazil. They have in common the potential or actual impact on migratory species that depend on the surrounding areas where the infrastructure is located as well as impacts on the populations that have different sorts of relationships with the marine fauna.

The Offshore Wind Park case study showcases the importance of understanding the seascape as experienced by migratory fishes such as sea lamprey and shad, anadromous species that use both the sea and the river Minho basin during their lifecycle. The Afsluitdijk dike case study illustrates how the closure of the estuary had an impact on migratory fishes that transited between the estuary and the sea, resulting in the decline of biodiversity and, finally, the Port of Suape case study describes how the location and modifications brought by the Port may have a contribution for the rise in the shark encounters along the urban marine areas of the city of Recife due to the behaviour patterns of the bull and tiger sharks and the characteristics of the nearshore in the area.

Taking into consideration the fluidity of the water and the great mobility of migratory species, relevant insights are provided about the importance of looking at the spatial features and territory usage that exist beyond the infrastructure location. Moreover, it also clarifies how human-environment interactions can be affected by the implementation of marine infrastructure which can not only modify the environment but also have unexpected impacts on the multi-species entanglements between humans and marine fauna.

AUTISM AND HIGHER EDUCATION: A LOOK AT DESIGN

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Keywords: Universal design for learning, ASD, Service logics

2030 Sustainable Development Goals: SDG4, SDG10

This essay was developed as part of Seminar I, taught by Professor Dr. Paula Trigueiros, and proposes to highlight the potential of the Universal Design for Learning strategy, recognizing the vitality of personalized and flexible approaches to meet the diverse needs of students on the autistic spectrum. Data from national research highlights the significant gap in education for people with disabilities. Given the increasing identification of autistic individuals as a result of greater access to diagnosis, it is imperative that educational environments are properly prepared to welcome these students, with a view to achieving goals related to sustainable development, such as those stipulated in Goals 4 and 10.

The methodology adopted in this study is qualitative, based on a literature review, analysis of research on adaptations in higher education for autistic people and the collection of reports through different formats, such as podcasts, videos and personal messages. These reports provide an in-depth view of the experiences of individuals on the autistic spectrum in the academic environment. As a guide, the conclusions presented in Jennifer Sarret's article entitled "Autism and Accommodations in Higher Education: Insights from the Autism Community" are explored. This reference offers a valuable framework for contextualizing the practices and challenges associated with the inclusion of autistic people in higher education.

Universal Design for Learning is highlighted in Jennifer Sarret's article as a potential methodology to be used in educational environments and, by exploring the effectiveness of Universal Design for Learning in promoting inclusive educational environments, we question if it alone is enough to promote awareness and if adapting educational materials is enough to guarantee equity in these spaces. Faced with this question, we introduced service logic from an inclusive perspective as an approach with the potential to consider all interactions and agents as co-creators of solutions in the educational environment, in addition to being able to put into practice the UDL application model proposed by Schwanke, Smith and Edyburn.

This essay concludes by highlighting the importance of a holistic approach to promoting social inclusion, involving awareness, educational and architectural adaptation to ensure equity for all students. Furthermore, given the increasing prevalence of autism diagnoses, it is crucial to conduct further research in this area, with a particular focus on the adult population, often neglected in large investigations.

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How Sustainable is your Programming Language? Analysing the Impact of PowerCap on Energy Efficiency of Programming Languages

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Keywords: Green Software, Programming Languages, RAPL

2030 Sustainable Development Goals: SDG9, SDG12, SDG17

This abstract provides a concise summary of an in-depth investigation into the energy efficiency of sorting algorithms implemented in various programming languages, employing statistical analysis techniques and multi-criteria optimization methods.

The study considers parameters such as development cost, execution time, energy consumption, cores' temperature, and memory consumption. We utilize the PowerCap library to monitor and control processor power consumption for enhanced energy efficiency assessment. To measure the energy consumption of the sorting algorithms implemented in all programming languages under consideration, we employ the Running Average Power Limiting (RAPL) interface from Intel.

The research encompasses a thorough examination of three sorting algorithms across thirteen programming languages. Quick Sort demonstrated superior performance in execution time, especially under enforced power caps. Notably, the programming language C emerged as the most optimal choice, showcasing superior execution time and power efficiency. In contrast, Selection Sort exhibited weaker performance under power limitations, and Kotlin demonstrated comparatively lower efficiency in both execution time and power metrics.

The study's analysis provides profound insights into the energy efficiency of sorting algorithms across programming languages, highlighting the significance of parameters on algorithm evaluation and language ranking. Multi-criteria optimization emphasizes the critical role of time and performance in the assessment of sorting algorithms, underscoring the efficiency variations among programming languages.

In conclusion, the study offers valuable insights into the energy efficiency of sorting algorithms, emphasizing the necessity of language-specific optimizations for energy-efficient software solutions. The combined use of statistical analysis and multi-criteria optimization provides a comprehensive perspective on sorting algorithm performance, facilitating informed decision-making in energy-efficient software development. The PowerCap library's effectiveness in managing and optimizing processor power consumption contributes to a more sustainable computing environment. Overall, this study adds a nuanced perspective by specifically evaluating three sorting algorithms across thirteen programming languages, elucidating the impact of power limitations on their performance.

NÚCLEO DE INVESTIGAÇÃO EM POLÍTICAS ECONÓMICAS

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THE PROMOTION OF SUSTAINABILITY IN HIGHER EDUCATION INSTITUTIONS: KEY FACTORS TO ADOPT FROM THE ORGANIZATIONAL PERSPECTIVE

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Keywords: Sustainability, Higher Education Institutions, Development

2030 Sustainable Development Goals: SDG4, SDG11, SDG12

This abstract focuses on presenting concepts and actions that Higher Education Institutions (HEIs) must adopt for a concise implementation of Sustainability guidelines on an organizational level. Since HEIs pursue a significant role in civil society forming individuals on an educational and civil level with the transmission of ideas, the strengthening of Sustainable Development is a core factor that must be stimulated by those educational organizations.

Sustainability as an academic study area has been heavily influenced by the status quo that our globalized civil society is currently facing. The excessive production and consumption of goods led humans to rethink and evaluate their lifestyles, which influenced different alternatives that can create a positive impact on a societal level. In this context, it makes sense that HEIs increase their engagement and promotion for sustainable transition.

Furthermore, the sustainability commitment of HEIs is a factor that reaches different directions and emerges with creative solutions. The implementation of sustainable goals proposed by the author focuses on topics such as digitalization, responsible consumption, and awareness promotion.

Even digitalization isn't oblivious to HEIs, there is a considerable number of internal processes that should be evaluated to maximize the services on an organizational level that stimulate the sustainable transition at the same time. There is an urgent necessity of rethinking and understanding that digitalization improves the quality of services and processes' transformation can be implemented easier than it appears. Is paper necessary for some processes? How does dislocation to physical facilities affect the city that those HEIs are in?

Moving on, responsible consumption will become a reality if the HEIs campuses promote it in direct or indirect ways. Which are the energy sources of the campus? Does the campus have efficient recycling facilities? How do the campuses manage food waste? Some of those examples are factors that even if they look obvious, some universities still struggle to manage properly.

Finally, the awareness promotion must be done with clear communication and with student participation. Digitalization is also a core resource able to stimulate the importance of sustainability.

To conclude, the engagement of HEIs on sustainable development is something crucial and that is possible to be expressed effortlessly. The know-how from pioneering HEIs on sustainability, maximization of digitalization, the promotion of engagement and awareness, and finally the revaluation of the current service design of the organization is always necessary to boost HEI's sustainable transition, following the 2030 Sustainable Development Goals.

FULL-TIME EDUCATION: ASSESSMENT OF THE IMPACT ON LEARNING OF THE BRAZILIAN PROGRAM NOVO MAIS EDUCAÇÃO

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Keywords: Full-time Education, Difference-in-Differences, Learning

2030 Sustainable Development Goals: SDG4

Although there is no consensus on the effectiveness of full-time education on learning, several Latin American countries have developed programs to extend school hours to achieve a higher level of student performance. In Brazil, the federal government implemented two policies to increase school hours: the Mais Educação Program (PME), from 2008 to 2017, and the Novo Mais Educação Program (PNME), in 2018 and 2019. Therefore, this article evaluates the impact of PNME on student learning and discussion on the effectiveness of the PNME design in relation to the previous policy, PME.

We used official data from the Brazilian government and the methodology combined Difference in Differences with propensity score matching to evaluate students' grades in mathematics and languages. Although recent developments show that the TWFE is biased, to evaluate policies that are implemented over a period, the PNME was implemented all at once, making this case a classic 2x2, allowing for the adoption of the TWFE.

For the initial years of primary education, the results show a positive impact on learning, but for the final years the results were ambiguous: a null effect on language students' grades and a negative impact on mathematics test results. A result consistent with the literature that points to the cumulative effect of learning. However, these results were more promising than those of its predecessor, the PME, which can be attributed to the design of the PNME being more focused on expanding the hours of language and mathematics learning. Our results indicate that the way in which the integral education policy is designed can directly impact the results obtained in student learning. The design of the PNME is focused on education as measured by national tests, while the PME had no such focus.

This research contributes new evidence on the effectiveness of comprehensive education. Furthermore, it brings into discussion the relevance of an adequate design to obtain the expected results. We suggest that future studies compare other policies with different designs to check whether there are consistencies between the designs that obtained positive learning results.

2030 SUSTAINABLE DEVELOPMENT GOALS

This book compiles the works presented by doctoral students at the 1st edition of the UMinho Research & Innovation Open Days, held on January 30 and 31, 2024. This event stood out as a milestone in promoting research, innovation, and interdisciplinary and international collaboration at the University of Minho, celebrating the scientific achievements of its academic community and fostering innovative solutions aligned with the Sustainable Development Goals (SDGs) for 2030.

The abstracts compiled here cover areas such as biotechnology, sustainable energy, legal studies, and psychology, highlighting the diversity and impact of UMinho's research ecosystem. This publication aims to inspire new collaborations and strengthen the commitment to innovative and sustainable scientific solutions to address global challenges.

UMinho Editora

Universidade do Minho

ISBN 978-989-9074-65-1