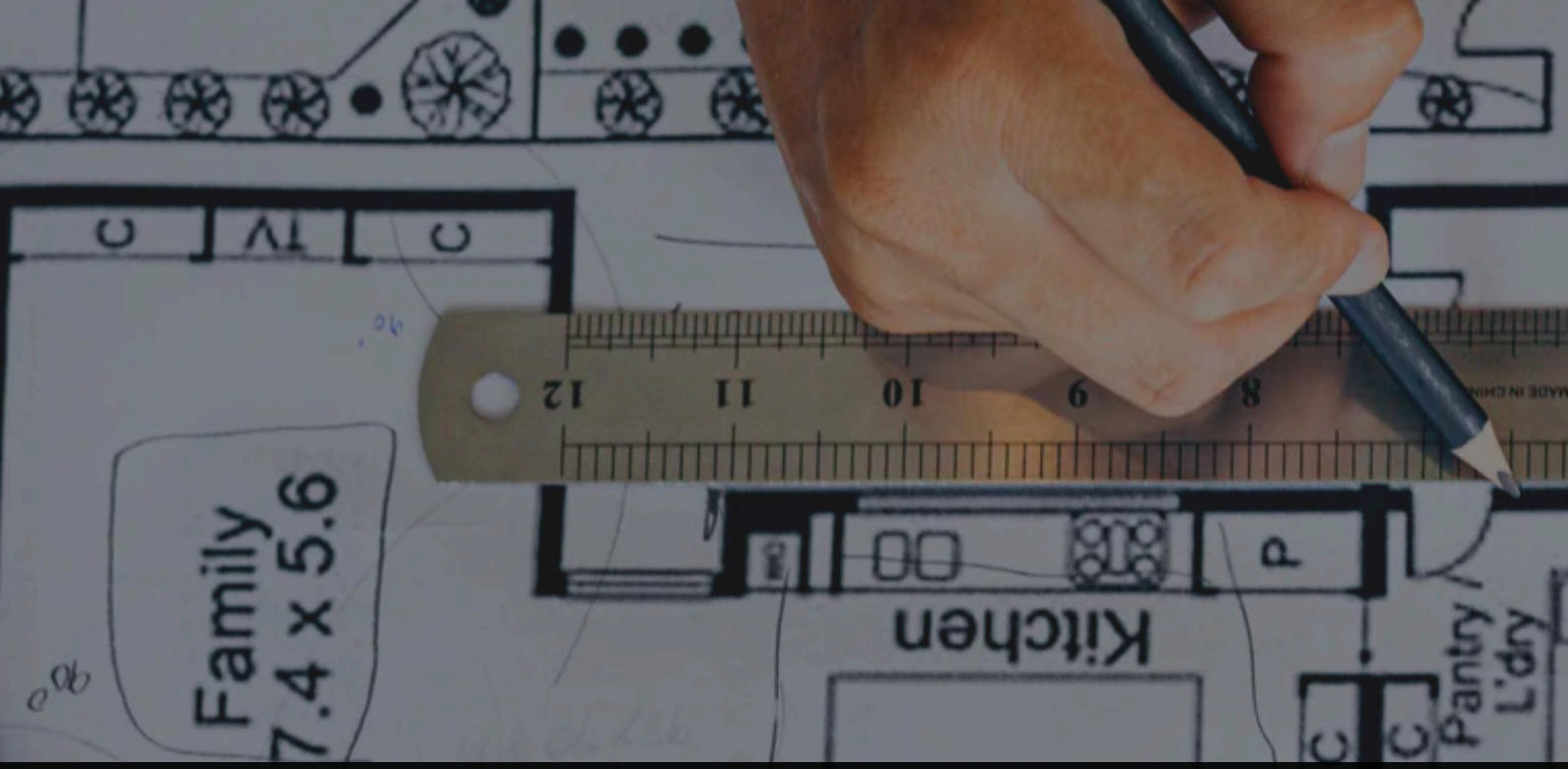


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## 12TH INTERNATIONAL CONFERENCE ON ENGINEERING AND NATURAL SCIENCES

## BOOK OF ABSTRACTS




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# BOOK OF ABSTRACTS OF THE 12th INTERNATIONAL CONFERENCE ON ENGINEERING AND NATURAL SCIENCES (ICENS 2026)

## OCTOBER 14 TO 18, 2026 IN SARAJEVO, BOSNIA AND HERZEGOVINA

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# WELCOME TO ICENS 2026

On behalf of the organizing committee, we are pleased to announce that the 12th International Conference on Engineering and Natural Sciences (ICENS 2026) was held from October 14 to 18, 2026 in Sarajevo, Bosnia and Herzegovina. ICENS provides an academic platform for researchers to present their latest findings and to discuss emerging technologies and research directions in engineering and the natural sciences. This year's conference brought together scientists, researchers and practitioners from many countries to share their experiences and research results. The scientific program focused on current advances in research and their practical applications across engineering and the applied sciences. Our goal is to provide an international scientific forum that enables the interactive exchange of state-of-the-art knowledge. We would like to thank all authors, reviewers and participants for their valuable contributions, and we hope that this Book of Abstracts will serve as a useful reference for future research.

Best regards,

**Prof. Dr. Özer ÇINAR**
*Chairman of the Conference*

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# OPENMC ANALYSIS OF NEUTRON FLUX AND ABSORPTION DISTRIBUTIONS IN A SIMPLIFIED MSR PASSIVE DRAINAGE TANK WITH A TUNGSTEN CARBIDE (WC) SHELL BY USING THE CONSTANT SOURCE APPROACH

ABSTRACT 01 · ICENS 2026

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**Abstract:**

In this study, the first-order neutronic behavior of a tungsten carbide (WC) shell used for the passive drain container of a molten salt reactor (MSR) was analyzed in terms of neutron flux, absorption, and hot spot distributions using an OpenMC-based fixed-source approach. In MSR systems, the passive drainage tank is a critical component of passive safety, as it allows the fuel salt to be removed from the reactor region by gravity alone—without the need for energy expenditure or a drainage system—in the event of a potential accident or system shutdown. It also facilitates the transition of the fuel salt to a subcritical configuration within the reactor and the passive removal of decay heat. The geometric model of the drain tank consists of a cylindrical LiF-$BeF_2$-$UF_4$ drain salt volume with an inner radius of 40 cm and a height of 120 cm, surrounded by a 2 cm thick WC shell. The OpenMC calculation was performed in the neutron constant source mode, using an isotropic source with a Watt-type fission spectrum and a regular mesh tally of 80 x 80 x 56. Analyses of the neutron flux, absorption, surface flux, and energy-grouped spectrum tally were performed. OpenMC, an open-source code, is widely used for Monte Carlo neutron transport analyses based on continuous energy sections and structured HDF5 outputs. The analyses revealed that the flux forms a broad plateau in the central salt volume and decreases toward the radial and axial boundaries. In addition to the contribution from the central volume, ring/band-shaped local capture regions were observed on the WC shell in the neutron absorption distribution. In the three-dimensional (3D) hot spot scatter plots, it was observed that high-flux points were primarily concentrated in the central volume, while high-absorption points were associated with both the central volume and the shell boundary. As a conclusion, this demonstrates that the WC shell in the designed drainage tank can be considered a functional candidate for a passive barrier in terms of neutron capture and radiation attenuation. Future analyses plan to address source intensity normalization, statistical uncertainty reporting, isotopic Li-7 enrichment, temperature feedback, activation, and corrosion etc. deeply in detail.

**Keywords:** Molten Salt Reactor, OpenMC, Tungsten Carbide, Passive Drainage Tank, Neutron Flux, Fixed Source Approach

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# ANALYSIS OF THE THREE-DIMENSIONAL AXIAL DEPTH SCAN OF A $B_4C$ CONTROL ROD IN A $UTHO_2$-FUELED BWR-TYPE LIGHT-WATER REACTOR USING THE OPENMC CODE

ABSTRACT 02 · ICENS 2026

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**Abstract:**

This study presents an analysis of an OpenMC-based parameter screening script and the corresponding critical results, which investigate the full three-dimensional (3D) axial penetration effect of a Boron-Carbide ($B_4C$) control rode in a $UThO_2$-based, light-water-cooled, BWR-like pin-cell model. Thorium-containing fuel options have been of interest in recent years due to their potential to diversify fuel sources in thermal-spectrum reactors, reduce long-term actinide production, and develop different fuel cycle strategies; however, the neutronic behavior of these options exhibits high sensitivity to moderation, initial fissile support, and core. In parallel, BWR reactivity control relies on bottom-entry cruciform control blades due to the higher water density and thermal neutron economy in the lower region, and $B_4C$ is one of the primary absorber materials in these systems. The examined script utilizes OpenMC's eigenvalue solution approach and represents the axial blade insertion as a physical height in the z-direction. In a scan consisting of 3,150 cases, the lowest effective neutron multiplication factor, keff was found to be 0.07238 and the highest keff was 1.69116; a solution directly surrounding the target keff value of 1.000 could not be produced. The supercritical state closest to the target has a keff of 1.17711 ± 0.00109, while the subcritical state closest to the target has a keff of 0.42250 ± 0.00047. The results indicate that the control blade insertion depth is the dominant parameter in this model; in contrast, blade thickness remains secondary within the selected width range. However, since the study involves an idealized pin-cell equivalent under reflective boundaries rather than the full BWR bundle geometry, the obtained trends should be interpreted as a high-fidelity neutronic pre-assessment rather than direct core licensing data.

**Keywords:** OpenMC, BWR, Thorium Fuel, $B_4C$ Control Blade, Effective Neutron Multiplication Factor

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# ANALYSIS OF KEY COST COMPONENTS INCREASING THE VALUE OF LOST LOAD FOR SLOVENIAN HOUSEHOLD CONSUMERS

ABSTRACT 03 · ICENS 2026

**Jerneja Bogovič[a*], Marko Kolenc[b], Miloš Pantoš[a]**

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**Abstract:**

Due to the increasing dependence of modern society on a reliable supply of electricity, the economic assessment of electricity supply interruptions has become an important aspect of power system planning and regulation. Various indicators can be used to estimate the costs associated with supply interruptions, with the value of lost load (VoLL) being one of the most commonly used. VoLL is also an important indicator within the European Union regulatory framework, as it is used in the assessment of reliability standards and the economic value of lost load.

In 2023, the VoLL was re-estimated using the damage assessment approach. The results show that the total value of VoLL almost doubled, increasing from 10,576 €/MWh in 2016 to 17,233 €/MWh in 2023. An even more pronounced increase was observed for residential consumers, where VoLL increased from 13,121 €/MWh to 23,301 €/MWh. Due to this significant increase, an additional analysis of the cost components contributing to the higher value was carried out.

The analysis showed that the largest share of the increase in total estimated damage can be attributed to the categories of quality of life, loss of income and the cost of repair of electrical appliances. These findings are consistent with current socio-technological trends. Residentials are increasingly equipped with a greater number of electrical appliances, many of which are also more expensive and technologically complex. In addition, electricity is increasingly used to power heating, cooling and ventilation systems, while the spread of remote work means that power outages are more often associated with income losses. Finally, due to changes in dietary habits, the cost of spoiled food no longer represents the dominant cost category, as was typically the case in the past.

**Keywords:** Customer Damage Function, Electricity Interruptions, Residential Consumption, Value of Lost Load

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# ESTIMATING THE TARIFF DIFFERENTIAL REQUIRED TO INDUCE LONG-TERM BEHAVIOURAL CHANGES IN RESIDENTIAL ELECTRICITY CONSUMPTION IN SLOVENIA

ABSTRACT 04 · ICENS 2026

**Jerneja Bogovič[a*], Marko Kolenc[b], Miloš Pantoš[a]**

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**Abstract:**

The increasing share of renewable energy sources and the electrification of heating and transport are increasing the need for demand-side flexibility. Residential consumers represent an important source of such flexibility; however, its actual availability strongly depends on user behaviour, daily habits, perceived comfort reduction, and financial incentives. This paper analyses the willingness of residential consumers in Slovenia to permanently change their electricity consumption habits and estimates the tariff differential required to induce such changes.

The analysis is based on survey results and considers several long-term flexibility measures, including the use of flexible household appliances only during night-time and weekends, allowing a wider temperature range for domestic hot water, and a permanent reduction of indoor heating temperature by 1, 2, and 3 °C.

The results show that more than 60% of participants would be willing to permanently change their habits for measures with a limited impact on comfort, namely the use of household appliances, domestic hot water preparation, and lowering the heating temperature by 1 °C. The main threshold of the normalized cost curve occurs at approximately 40 €/MWh, expressed relative to total annual household electricity consumption. At the same time, only around 30% of participants would be willing to permanently lower the heating temperature by 3 °C.

The results indicate that tariff signals can be an effective mechanism for encouraging long-term implicit flexibility among residential consumers, particularly for measures with limited impact on comfort.

**Keywords:** Demand-Side Flexibility, Residential Consumers, Behavioural Change, Demand Response, Normalized Cost Curve

# FORMALDEHYDE- AND EPICHLOROHYDRIN-CROSSLINKED SUGAR BEET PULP CATION EXCHANGE RESINS: STRUCTURAL MODIFICATION, ISOTHERMAL EQUILIBRIUM, AND HEAVY METAL SORPTION KINETICS

ABSTRACT 05 · ICENS 2026

**Hasan Arslanoğlu[a*], Feride N. Türk[b]**

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**Abstract:**

Agro-industrial by-products such as sugar beet pulp (SBP) represent renewable, cost-effective matrices rich in pectic substances and cellulose; however, their native structural instablity and leaching inclination severely constrain direct implementation in column operations. This investigation details the targeted chemical functionalization of SBP through dual-stage crosslinking using formaldehyde and epichlorohydrin, alongside polymer graft modification, to yield robust bio-based cation-exchange resins with structural integrity. Characterization of functional group alterations, surface morphology, and thermal degradation kinetics confirmed successful etherification, crosslinking, and polycarboxylic acid enrichment. Batch and continuous-flow sorption experiments were conducted to elucidate the thermodynamic and kinetic mechanisms governing heavy metal ion uptake (specifically divalent $Pb^{2+}$, $Cd^{2+}$, and $Cu^{2+}$) from synthetic and industrial wastewater streams. Adsorption equilibrium datasets were modeled using the Langmuir, Freundlich, and Dubinin-Radushkevich isotherms, with the Langmuir model yielding maximum monolayer capacities (qmax) exceeding commercial benchmark resins. Kinetic studies revealed rapid equilibrium attainment following pseudo-second-order dynamics, wherein intraparticle diffusion and chemisorption via functional carboxylate/hydroxyl coordination serve as rate-determining steps. Thermodynamic parameters ($\Delta G° < 0$, $\Delta H° > 0$) verified the spontaneous and endothermic nature of the sorption process. Furthermore, multi-cycle regeneration trials demonstrated exceptional desorption efficiency using mild mineral acids, retaining over 92% sorptive capacity across five sequential sorption-elution cycles. These findings prove that chemically modified SBP serves as an efficient, highly durable bio-sorbent capable of meeting stringent environmental discharge standards.

This study was financially supported by the Scientific Research Projects Coordination Unit of Çanakkale Onsekiz Mart University under Project Number: FBA-2026-5460.

**Keywords:** Bio-Based Resins, Crosslinking, Epichlorohydrin, Heavy Metal Sorption, Isothermal Thermodynamics, Sugar Beet Pulp

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# FUNCTIONALIZED AGRICULTURAL RESIDUE HYDROGELS FOR INDUSTRIAL STREAM PURIFICATION: CATION EXCHANGE SELECTIVITY, JUICE DECOLORIZATION, AND CRYSTALLIZATION IMPACT

ABSTRACT 06 · ICENS 2026

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**Abstract:**

Downstream processing in sugar refining and complex industrial liquid remediation requires selective ion separation, organic pigment removal, and minimal target analyte loss. Standard synthetic ion-exchange resins and granular activated carbons present substantial operational expenditure due to high thermal regeneration costs and fouling susceptibility. This study investigates the engineering application of functionalized carbohydrate-based cation exchange resins and water-soluble polymer-modified cellulose fibers derived from agricultural residues for raw sugar juice purification and heavy metal abatement. Packed-bed column dynamics, breakthrough curves, and mass transfer dynamics were evaluated under variable hydraulic loading rates, bed depths, pH regimes, and temperature profiles. The engineered bio-sorbents exhibited high selectivity toward divalent and trivalent inorganic cations ($Ca^{2+}$, $Mg^{2+}$, $Fe^{3+}$) and high-molecular-weight colorants without inducing sucrose inversion, mass loss, or inhibiting subsequent crystallization kinetics. Mass transfer modeling indicated film diffusion as the predominant transport mechanism in fixed-bed systems. Comparative analysis with conventional synthetic resins demonstrated equivalent decolorization efficiency (over 85%) and superior resistance to organic fouling. By eliminating molasses-forming cations and inhibiting non-enzymatic browning compounds, the modified biopolymers significantly optimize sucrose yield while reducing liquid waste generation, offering a sustainable, scalable framework for industrial effluent treatment and sugar refining. This study was financially supported by the Scientific Research Projects Coordination Unit of Çanakkale Onsekiz Mart University under Project Number: FBA-2026-5460.

**Keywords:** Breakthrough Dynamics, Decolorization, Fixed-Bed Adsorption, Industrial Effluent, Ion Exchange Selectivity, Sugar Purification

# SPECTROSCOPIC, MORPHOLOGICAL, AND ISOTHERMAL EVALUATION OF MODIFIED POLYMERIC BIO-SORBENTS DERIVED FROM AGRO-INDUSTRIAL WASTE FOR HEAVY METAL SEQUESTRATION

ABSTRACT 07 · ICENS 2026

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**Abstract:**

The functionalization of naturally occurring biopolymers represents a crucial strategy for overcoming the inherent mechanical and chemical limitations of untreated lignocellulosic sorbents in industrial water purification. In this study, raw agricultural residues and sugar beet processing by-products were subjected to target-specific chemical modification using crosslinking agents (epichlorohydrin and formaldehyde) and functionalizing polymers to synthesize novel cation-exchange resins. Comprehensive surface characterization was performed using Fourier-transform infrared spectroscopy (FTIR), scanning electron microscopy coupled with energy-dispersive X-ray spectroscopy (SEM-EDX), and Brunauer-Emmett-Teller (BET) surface area analysis to elucidate structural and morphological transformations post-modification. FTIR spectra confirmed the incorporation of carboxyl, carbonyl, and ether functional linkages responsible for enhanced chelation, while SEM micrographs revealed an increasingly porous, highly textured surface matrix. Equilibrium sorption experiments across varying pH, ionic strength, and temperature regimes demonstrated high uptake efficiency for divalent heavy metal ions ($Pb^{2+}$, $Cd^{2+}$, and $Cu^{2+}$). Non-linear isotherm fitting established that the Langmuir model provided the best fit ($R^2 > 0.99$), indicating homogeneous monolayer chemisorption onto specific energetic sites with a significantly elevated maximum sorption capacity (q_max) compared to uncrosslinked raw biomass. Kinetic modeling confirmed that the rate of metal capture follows pseudo-second-order dynamics, governed primarily by film diffusion and intraparticle transport mechanisms. Thermodynamic analysis yielded negative values for standard Gibbs free energy, confirming the thermodynamic favorability and spontaneity of the adsorption process. The engineered bio-sorbent exhibits superior structural durability, making it a viable candidate for sustainable wastewater remediation. This study was financially supported by the Scientific Research Projects Coordination Unit of Çanakkale Onsekiz Mart University under Project Number: FBA-2026-5460.

**Keywords:** Characterization, FTIR-SEM Analysis, Isotherm Modeling, Monolayer Chemisorption, Surface Functionalization, Wastewater Treatment

# FIXED-BED COLUMN PERFORMANCE AND DESORPTION-REGENERATION DYNAMICS OF FUNCTIONALIZED CARBOHYDRATE-BASED RESINS FOR INDUSTRIAL WASTEWATER REMEDIATION

ABSTRACT 08 · ICENS 2026

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**Abstract:**

While batch-scale bio-sorbents demonstrate high theoretical uptake capacities, their transition into real-world industrial separation processes requires robust performance under continuous flow conditions and multi-cycle operational reusability. This investigation evaluates the fixed-bed column dynamics, breakthrough behavior, and desorption kinetics of chemically modified carbohydrate-based cation-exchange resins synthesized from modified cellulose and pectic agricultural residues. Continuous-flow experiments were executed under varying hydraulic flow rates, bed height configurations, and influent target metal ion concentrations. Mathematical modeling of breakthrough curves using the Thomas, Adams-Bohart, and Yoon-Nelson models demonstrated excellent predictive agreement, revealing extended breakthrough times and high bed capacity utilization at optimized flow rates. To assess long-term operational feasibility, sequential sorption-desorption cycles were conducted using diluted mineral acid eluents (HCl and $HNO_3$). The crosslinked polymeric matrix exhibited remarkable chemical stability, maintaining over 90% of its initial sorption capacity across five consecutive regeneration cycles without undergoing matrix dissolution or structural compaction. Furthermore, competitive ion-exchange studies in multi-component metal solutions showed high selectivity toward toxic heavy metal cations over light alkali and alkaline earth metals ($Na^+$, $K^+$). The findings validate that these functionalized biopolymeric resins possess the mechanical strength, kinetic throughput, and regeneration capacity necessary for scalable, cost-effective integration into industrial wastewater treatment plants. This study was financially supported by the Scientific Research Projects Coordination Unit of Çanakkale Onsekiz Mart University under Project Number: FBA-2026-5460.

**Keywords:** Breakthrough Modeling, Column Dynamics, Desorption Efficiency, Fixed-Bed Adsorption, Multi-Cycle Regeneration, Polymeric Resins

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# CHARACTERIZATION OF $AL_2O_3$/NI/TI COMPOSITES FABRICATED VIA THE SLIP CASTING METHOD

ABSTRACT 09 · ICENS 2026

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**Abstract:**

In this study, ceramic-metal composites in the $Al_2O_3$/Ti system were investigated. The research aims to characterize the microstructure and mechanical properties of innovative $Al_2O_3$/Ti composite fabricated via the slip casting method, which is one of the cheapest and most effective methods of forming composites. In the manufacturing process, a solution of nanometric alumina and submicrometric titanium as metallic components was used. In the research, composites with 10% of metallic phase and 50% of solid phase were produced during the sintering at 1450°C. Many research techniques were used to characterize the base powders, the slurries used in the slip casting method, and the composite samples after the sintering process in an air atmosphere. The initial powders, green body samples, and sintered composites were characterized by XRD, SEM/EDS studies, and density measurements using picnometric and Archimedes methods. Rheological properties and analysis of the sedimentation tendency of slurries were investigated as well. The microstructure and phase composition and mechanical properties of the sintered composites obtained were determined. A monotonic compression test and hardness measurements were used to investigate the mechanical properties of the composites. A fractography investigation was also carried out. Research results revealed that the proposed method of fabrication allows for obtaining a ceramic-metal composite from $Al_2O_3$/Ti system enhanced with new phases. XRD studies showed that after the sintering process, new $TiO_2$ and $Al_2TiO_5$ (Tialite) phases appeared in the produced composites. The presence of Tialite as a new phase significantly affects the final properties of the composite due to its low thermal expansion coefficient, high thermal shock resistance, relatively high refractoriness, and high chemical resistance. The prepared samples were characterized by a density exceeding 96% of the theoretical density.

**Keywords:** Composites, Ceramic, Titanium, Slip Casting, Sintering

# QUANTUM ALGORITHM SIMULATION ON CLASSICAL HARDWARE: SCALING AND NOISE ANALYSIS OF GROVER'S SEARCH WITH QISKIT

ABSTRACT 10 · ICENS 2026

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**Abstract:**

Quantum algorithms promise substantial speedups for search and optimization tasks, yet access to fault-tolerant quantum hardware remains limited, making classical simulation the primary tool for algorithm development, verification, and education. In this work, Grover's quantum search algorithm is implemented and analyzed systematically on classical hardware using the open-source Qiskit framework running on a free cloud notebook environment. The implementation is first verified against the closed-form theory of the algorithm: the simulated success probability as a function of the number of Grover iterations is compared with the analytic expression derived from the geometric interpretation of the oracle and diffusion operators, and the optimal iteration count is confirmed to follow the well-known square-root law. The computational cost of statevector simulation is then characterized as a function of the number of qubits, quantifying the exponential growth of both runtime and memory that defines the classical simulation barrier, together with the scaling of the transpiled circuit depth and gate count. Finally, realistic noise models including depolarizing and readout errors are introduced, and the success probability is mapped over the plane of error rate and problem size in order to identify the region in which the quantum search retains an advantage over random guessing. The multiple-solution case and the associated overshooting effect are also examined. The complete study is reproducible in a standard Python environment without any specialized hardware, and the presented workflow is proposed as a practical template for benchmarking quantum algorithms on classical computers.

**Keywords:** Quantum Computing, Grover's Algorithm, Qiskit, Quantum Circuit Simulation, Noise Analysis

# TIME-DEPENDENT QUANTUM TUNNELING OF GAUSSIAN WAVE PACKETS: A SPLIT-OPERATOR FOURIER METHOD STUDY

ABSTRACT 11 · ICENS 2026

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**Abstract:**

Quantum tunneling is a cornerstone of modern physics, underlying phenomena from alpha decay to the operation of tunnel diodes and scanning tunneling microscopy, yet it is most often taught and analyzed through time-independent plane-wave solutions. In this work, the tunneling of Gaussian wave packets through potential barriers is investigated dynamically by solving the time-dependent Schrödinger equation with the split-operator Fourier method implemented entirely in Python using open-source libraries. The numerical scheme is validated through three independent benchmarks: the free-particle spreading of a Gaussian packet is compared with its exact analytic solution, the conservation of the norm and of the mean energy is monitored over the full propagation time, and the transmission through a rectangular barrier is compared with the exact stationary plane-wave formula. The time evolution of packets incident on single barriers is then visualized through spatial snapshots and space-time density maps, and the transmitted and reflected probabilities are followed in time. By projecting the transmitted packet onto momentum space, the full energy-resolved transmission coefficient is extracted from a single wave-packet simulation and shown to agree with the analytic result, and the expected exponential suppression of tunneling with barrier width and height is quantified. Finally, resonant tunneling through double-barrier structures is examined: sharp transmission resonances are resolved, and the transient trapping of the wave packet in the inter-barrier region at resonance is demonstrated. The presented framework provides an accurate, fully open-source tool for studying and teaching quantum dynamics.

**Keywords:** Quantum Tunneling, Time-Dependent Schrödinger Equation, Split-Operator Method, Wave Packet Dynamics, Resonant Tunneling

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# PREDICTING THE THERMAL BEHAVIOR OF SUSTAINABLE BIOCOMPOSITE FILMS USING FINITE ELEMENT SIMULATION



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**Abstract:**

The application of the finite element simulation to predict the properties of polymer composites prior to the manufacturing process is of considerable importance, as it can significantly reduce production costs and save time. In this study, carboxymethyl cellulose (CMC) and chitosan were used as the matrix materials, while calcium carbonate, zeolite, and hemp waste powder were employed as fillers to fabricate four different composite film formulations. The thermal behavior of these films was evaluated through heat transfer analysis under both steady-state and transient conditions. The steady-state analysis revealed that the incorporation of hemp waste powder reduced the heat flux, whereas the addition of calcium carbonate and zeolite increased the heat flux and enhanced heat transfer within the material. In contrast, the transient analysis exhibited an opposite trend, demonstrating that increasing the volume fraction of hemp waste powder accelerated heat penetration through the composite films. These findings indicate that the selection of an appropriate composite film should be based on its intended application and the dominant mode of heat transfer in the service environment, whether steady-state or transient. Furthermore, the results suggest that finite element simulation, alongside other predictive approaches such as machine learning and artificial neural networks, can serve as an accurate and efficient tool for estimating the properties of composite films prior to fabrication.

**Keywords:** Finite Element Simulation, Carboxymethyl Cellulose, Hemp Waste Powder, Steady-State Heat Transfer, Biocomposite Films

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# EVALUATION OF THE MECHANICAL PROPERTIES OF AA2024 ALLOY JOINTS PRODUCED BY FRICTION STIR WELDING UNDER COMBINED LOADING CONDITIONS AT HIGH STRAIN RATES

ABSTRACT 13 · ICENS 2026

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**Abstract:**

Friction stir welding (FSW) of the precipitation-hardened AA2024 aluminum alloy typically results in a reduction in tensile strength compared to the as-received material. This phenomenon is primarily associated with the softening of the heat-affected zone (HAZ), resulting from the thermal cycle of the process affecting the precipitation of the strengthening phase S ($Al_2CuMg$). The objective of this study is to evaluate the effect of combined high-strain rate on the mechanical properties of FSW joints in the AA2024 alloy.

Butt-welded 3-mm-thick AA2024 sheets were subjected to a combined high-strain rate corresponding to 64–99% of the base material's yield strength ($Rp_{o,2}$). The mechanical response of the joints was evaluated based on static tensile tests and Vickers microhardness mapping ($HV_{o.1}$). Microstructural observations were performed using light microscopy, while fracture surfaces were analyzed using scanning electron microscopy (SEM). The statistical significance of the observed changes was assessed using one-way and two-way analysis of variance (ANOVA). The uncertainty of the strengthening factor was estimated using the Monte Carlo propagation method.

The results showed a non-monotonic relationship between the level of preload and the strengthening effect. A load of up to 73% $Rp_{o,2}$ increased the tensile strength of the joints to approximately 500 MPa, which corresponds to an improvement of about 16% compared to the post-weld condition and allowed for a strength exceeding that of the base material. At higher load levels (≥81% $Rp_{o,2}$), the strengthening effect gradually diminished, while a load of 99% $Rp_{o,2}$ led to the failure of the specimens. ANOVA analysis confirmed significant strengthening of the weld nugget and the TMAZ zone, while the HAZ remained the weakest area of the joint.

The results indicate that combined high-strain-rate deformation at approximately 70% $Rp_{o,2}$ can be an effective method for mechanical conditioning of AA2024 joints produced by the FSW method. This method allows for the reserve capacity for strain hardening of the joint regions to be exploited without significantly altering the grain structure or the fracture mechanism.

**Keywords:** Friction Stir Welding (FSW), Combined High-Strain Rate, AA2024 Alloy, Vickers Microhardness Mapping

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# THE ORIGINS AND EVOLUTION OF CHATBOTS IN THE CONTEXT OF HUMAN-MACHINE INTERACTION

ABSTRACT 14 · ICENS 2026

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**Abstract:**

The interaction between humans and machines, in both its limitations and possibilities, has long been a subject of interest. Research on human-machine interaction poses certain questions across disciplines such as cybernetics, artificial intelligence, and cognitive philosophy. Some concern the extent to which such interaction can succeed, others the degree to which this success can be applied. In line with these inquiries, chatbots have been designed using programming languages, and the capacities of this communication have been theoretically tested through pioneering benchmarks such as the Imitation Game.

This study aims to delve into the origins and historical development of chatbots in both theoretical and technical contexts. It also examines the programming languages used to build chatbots, the role of natural language processing, extending from Turing's Imitation Game to ELIZA, which was designed by Weizenbaum using the MAD-SLIP programming language, and to modern large language model-based chatbots such as Gemini, ChatGPT, and Claude.

The research is conducted from the perspective of the history of science and technology. In this scope, the development process is examined in a historical context. In line with this, artificial intelligence, which emerged as a new field in 1956, named by McCarthy, is analyzed through this lens. In addition, cybernetics, which was established by Wiener in 1948 and whose roots extend to Al-Jazari in the 13th century through the automaton tradition, is addressed in the study. The history of chatbots is examined alongside these two domains.

In conclusion, from the early examples of chatbots to today's large language models, the history of human-machine interaction is researched. This study also examines whether this historical development constitutes cumulative progress and, if not, which paradigms have shifted as well. Hence, it aims to contribute by illuminating nearly a century of history in this relatively contemporary field.

**Keywords:** History of Chatbots, History of Artificial Intelligence, History of Cybernetics, History of Human–Machine Interaction

# EXPERIMENTAL ANALYSIS OF NON-UNIFORM TEMPERATURE EFFECTS ON LAMB WAVE-BASED DAMAGE DETECTION

ABSTRACT 15 · ICENS 2026

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**Abstract:**

Piezoelectric transducers have been widely used for damage detection in the structural health monitoring (SHM) of various engineering structures. Among existing damage detection methods, the Lamb wave method is addressed in this research. The method's principle involves installing at least one pair of transducers on the structure being monitored, with one transducer operating as an actuator to generate waves and the other as a sensor to receive the corresponding wave. Any damage along the wave path between the transducers alters the electrical signal read by the sensor, enabling its detection. Among the various practical issues hindering the application of the method to real structures, the effect of temperature variation is considered the most critical, and researchers have proposed various compensation techniques. These techniques are validated through laboratory tests on specimens subjected to uniform temperature distribution, a condition rarely found in real structures. Therefore, this paper presents an experimental analysis of the influence of non-uniform temperature distribution on the Lamb wave method, an issue that has received little attention in literature. An aluminum plate was used as the test specimen, on which a pair of piezoelectric transducers was installed to generate and receive Lamb waves. The specimen was heated using a heat gun to achieve different uniform and non-uniform temperature distributions. Measurement and control of the temperature distribution were performed using a thermal camera. A multifunction data acquisition device connected to a personal computer was used to generate the excitation signal as well as to receive the electrical signal corresponding to the Lamb wave. Wave signals under different temperature distributions were analyzed and compared using the dynamic time warping (DTW) compensation method, in addition to a damage index. The results indicate that non-uniform temperature distribution can reduce the effectiveness of some compensation techniques, which may hinder damage detection in real structures.

**Keywords:** Piezoelectric Transducers, Lamb Waves, Temperature, Distribution

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# DETERMINATION OF POWDERY MILDEW DISEASE TOLERANCE IN SOME LOCAL GRAPE GENOTYPES COLLECTED FROM MOROCCO USING MOLECULAR MARKERS

ABSTRACT 16 · ICENS 2026

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**Abstract:**

In grape production, quality, yield, and disease tolerance are paramount in variety selection. In this context, powdery mildew is one of the most significant diseases causing problems in production. Disease control is a difficult and costly process. Despite numerous pesticide applications, sufficient success is not achieved, especially during rainy periods. The most important point in powdery mildew control is the use of disease-tolerant genotypes in production. In this study, the tolerance levels of local grape genotypes grown in Morocco to powdery mildew disease were determined using molecular markers. First, DNA isolation was performed from young leaves of grape genotypes. Then, PCR and electrophoresis were performed with VMC8g9, VMC1g3.2, UDV020a, and VMC9h4.2 primers. In the results obtained, a band indicating tolerance was obtained for one primer in some genotypes, for two primers in others, and for three primers in still others. In contrast, genotypes 8, 13, 74, 15, 20, 23, 26, 28, and 33 were found to carry tolerance markers for all four primers studied so far. On the other hand, some genotypes were found not to carry tolerance bands for any primer. The preliminary results obtained so far indicate significant differences in powdery mildew tolerance among the studied genotypes.

The promising genotypes obtained from this study will represent a new step in the production of high-quality and healthy grapes in both countries. Thus, materials will be created for a sustainable, environmentally friendly, and competitive production model.

**Keywords:** Grapevine, *Erysiphe necator* (Schw.) Burr., Local Genotype

# THE PROBLEM OF MINIMUM TIME IN BATCH DISTILLATION OF MULTICOMPONENT MIXTURES

ABSTRACT 17 · ICENS 2026

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**Abstract:**

A procedure is proposed for calculating the optimal reflux profile at which the desired amount of the first product of the required purity is obtained, with minimal process time, in the batch distillation of multicomponent mixtures. For this purpose, a dynamic optimization method known as the maximum principle is used. The procedure is tested on several separation tasks. A semi-rigorous process model is used, and the composition of the vapor phase at the top of the column is calculated using the nonlinear least squares method.

**Keywords:** Minimum Time, Batch Distillation, Multicomponent Mixtures

# INDUCTION WELDING OF ABS AND PLA SHEETS

ABSTRACT 18 · ICENS 2026

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**Abstract:**

This study examined the joining of ABS and PLA sheets printed with a 3D printer using the induction welding method. PLA and ABS composite films reinforced with iron powder were fabricated and melted under the inductive effect in the welding regions of the sheets to join the ABS and PLA sheets. The composite films were reinforced with iron particles, which accounted for 70% of their weight and had an average diameter of 100 µm. In the first stage, the melting times of the composite films in the induction coil were determined. The joints were then held in the coil for these melting times. The failure load and failure behaviour of the joints were determined under tensile load. Complete adhesion of the composite films to the weld surfaces was observed in all ABS and PLA joints under the inductive effect. The maximum failure load values for the PLA and ABS joints were 2499.71 N and 2728.07 N, respectively. This study has demonstrated that iron-reinforced, fully recyclable composite films can be used effectively in the production of joints for 3D-printed parts using induction.

**Keywords:** Induction Welding, ABS, PLA

# CELL ORIENTATION SWITCHES AND RELATIVE DENSITY TUNES THE AUXETIC RESPONSE OF A HYBRID MINIMAL-SURFACE LATTICE

ABSTRACT 19 · ICENS 2026

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**Abstract:**

Auxetic behaviour in triply periodic minimal surface (TPMS) lattices is commonly obtained by modifying the implicit surface equation, by mapping the surface into a constraining macro-shell, or by exploiting buckling. Each route alters either the governing geometry or the boundary conditions. This study examines whether auxeticity can instead be induced by unit-cell rotation alone. A hybrid Primitive–IWP surface was held fixed while the unit cell was rotated about a single axis at θ = 0°, 5°, 10°, 15° and 20° for four relative densities (ρ* = 0.189–0.348), and the full effective stiffness tensor was obtained by computational homogenization under periodic boundary conditions in Nitinol and PLA. Rotation reduced the in-plane modulus E11 by 88.8% at ρ* = 0.189 and by 48.3% at ρ* = 0.348, while E33 varied by less than 2.5%: a single parameter reconfigures the in-plane response and leaves the out-of-plane response intact. The in-plane Poisson's ratio crossed zero and reached −0.825 at θ = 20°, and the transition angle shifted from 2.17° to 8.82° with increasing density; every predicted angle was confirmed by an independent simulation to within 0.03°. Rotation also migrated the minimum-modulus direction from ⟨111⟩ toward ⟨110⟩ and raised the Gibson–Ashby exponent from 1.93 to 4.36, beyond the conventional stretching-to-bending range, whereas the shear exponent remained near 2.8. Cell orientation therefore switches the auxetic response on, while relative density sets the transition angle and the attainable magnitude, without altering the surface equation or requiring an external stimulus.

**Keywords:** Mechanical Metamaterial, Hybrid TPMS Lattice, Computational Homogenization, Auxetic Transition, Design by Orientation

This study was financially supported by the Scientific Research Projects Coordination Unit of Kocaeli University under Project Number: FOA-2025-4638.

# HOW MUCH OF A HOMOGENIZED PREDICTION SURVIVES IN A PRINTED LATTICE?

ABSTRACT 20 · ICENS 2026

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**Abstract:**

Periodic homogenization is widely used to predict the effective properties of architected lattices, but it assumes an effectively infinite periodic medium, whereas additively manufactured components are finite and bounded by free surfaces. This study quantifies how much of the prediction survives that transfer, using a hybrid Primitive–IWP TPMS lattice in which unit-cell rotation induces an auxetic response. Three approaches were compared: periodic homogenization; full-domain finite element analysis of a 2×2×2 block with traction-free lateral surfaces; and quasi-static compression of PLA specimens of 4×4×4 cells produced by fused deposition, with as-built density verified gravimetrically and transverse strain measured by image correlation. The two models agreed to within 12% in the unrotated state. Under rotation the finite block became stiffer than the periodic prediction: at $\theta = 20°$ the excess grew from 7% at $\rho^* = 0.348$ to 76% at $\rho^* = 0.189$, consistent with suppression of the cooperative folding mechanism near free surfaces, while 79–83% of the predicted auxetic magnitude was still recovered. The printed specimens were more compliant than both models by a consistent factor of 1.33 ± 0.09 across ten configurations, yet reproduced the rotation-induced stiffness reduction (61.7% measured against 64.8% predicted at $\rho^* = 0.269$). A 4.8% as-built density deficit and the compliance of the load train account for most of the offset: correcting the axial strain by image correlation brought the measured modulus to within 2.7% of the full-domain prediction, and the measured Poisson's ratio of −0.521 ± 0.008 lay within 1.2% of the homogenized −0.528. Finite size, as-built density, constituent stiffness and strain measurement are therefore separable sources of discrepancy.

**Keywords:** Architected Lattice, Additive Manufacturing, Finite-Size Effect, Image Correlation, Experimental Validation

This study was financially supported by the Scientific Research Projects Coordination Unit of Kocaeli University under Project Number: FOA-2025-4638.

# THE IMPACT OF HOURLY PTF FLUCTUATIONS ON SOLAR POWER PLANT REVENUES: A CASE STUDY OF A FACILITY WHOSE YEKDEM TERM HAS EXPIRED

ABSTRACT 21 · ICENS 2026

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**Abstract:**

In recent years, Turkey's energy policies have placed a strong emphasis on the use of renewable energy sources. The Renewable Energy Sources Support Mechanism (YEKDEM), which provided a feed-in tariff for solar power plants in previous years, will soon expire for plants commissioned between 2005 and 2020. As a result, these plants will be forced to transition to the spot electricity market, a situation that could pose significant financial risks for investors. In this study, the current financial status of a facility whose YEKDEM term has expired was analyzed using data from March 2026.

**Keywords:** YEKDEM, Solar Power Plants, Financial Risk, Market Integration, Market Clearing Price

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# INVESTIGATION OF THE EFFECTS OF SEASONAL SOILING LOSSES ON PHOTOVOLTAIC POWER PLANT PERFORMANCE USING PVSYST

ABSTRACT 22 · ICENS 2026

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**Abstract:**

In this study, the effect of dust accumulation and soiling on the surface of photovoltaic (PV) panels on electrical energy generation was analyzed using the PVsyst simulation software. A PV power plant with a capacity of 119.34 kWp DC and 100 kWe was modeled, and three different soiling scenarios were created while keeping the other system parameters constant. In Scenario 1, the soiling loss was set to 0%; in Scenario 2, a constant soiling loss of 5% was applied throughout the year; and in Scenario 3, monthly soiling rates varying between 2% and 10% were applied to represent seasonal conditions. As a result of the simulation, the annual electrical energy generation was calculated as 157,383 kWh, 151,071 kWh, and 150,222 kWh, respectively, while the performance ratios (PR) were calculated as 82.3%, 79.0%, and 78.6%, respectively. In the seasonal soiling scenario, annual energy generation decreased by approximately 4.55% compared to the reference case. In addition, the lower generation obtained in the seasonal soiling scenario compared to the constant 5% soiling case showed that the concentration of soiling particularly during periods of high irradiation and generation may have a greater impact on annual energy yield. The results indicate that considering monthly or seasonal soiling profiles instead of a constant annual soiling rate in PV power plant performance and generation forecasts may provide more realistic results.

**Keywords:** Photovoltaic Power Plant, PVsyst, Panel Soiling, Performance Ratio

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# ASSESSMENT OF THE APPLICABILITY OF STAND-ALONE BATTERY ENERGY STORAGE SYSTEMS IN THE TURKISH ELECTRICITY MARKET



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**Abstract:**

The increasing share of renewable energy sources in the electricity grid increases the importance of energy storage systems in terms of maintaining the generation-consumption balance and improving grid flexibility. In this study, energy storage technologies, particularly lithium-ion battery storage, were examined, and their potential for use in grid-connected applications was evaluated. By evaluating recent studies in the literature, the technical characteristics and application areas of battery storage systems and their potential contributions to the electricity grid were discussed. In addition, the position and applicability of stand-alone electricity storage facilities within the market were evaluated within the scope of the Regulation on Storage Activities in the Electricity Market currently in force in Türkiye. It was demonstrated that the energy arbitrage approach, based on storing energy during periods of low electricity prices and supplying it to the system during periods of high prices, may increase the economic potential of battery storage investments. As a result, it was evaluated that battery energy storage systems have significant potential in terms of the energy market, grid flexibility, and renewable energy integration, provided that appropriate technical and regulatory conditions are met.

**Keywords:** Energy Storage, Lithium-Ion Battery, Stand-Alone Storage, Energy Arbitrage

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# COMPARATIVE COST ANALYSIS IN HYBRID POWER GENERATION SYSTEMS

ABSTRACT 24 · ICENS 2026

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**Abstract:**

In this study, different energy generation systems designed to meet the electricity demand of a region with a daily energy consumption of 24,000 kWh and a peak load of 1,870.38 kW in Andırın district of Kahramanmaraş province were modeled and compared using the HOMER Pro demo software. Six scenarios consisting of different combinations of solar and wind energy, battery storage system, grid, and diesel generator were evaluated.

The results show that the integration of renewable energy sources into the system can significantly reduce dependence on the grid compared to the base scenario in which only the grid is used. Particularly in Scenario 3, where a 1,000 kW solar power plant and a 1,500 kW wind power plant were used together, the grid utilization rate decreased to 33.7%, while annual renewable energy generation reached 7,068,145 kWh. In Scenario 5, where solar, wind, and battery storage systems were evaluated together, the grid utilization rate was also 33.7%, and 1,780,382 kWh/year of energy was sold to the grid. As a result, the study demonstrates that hybrid renewable energy systems offer significant potential for reducing grid dependence and enabling more effective utilization of local energy resources.

**Keywords:** Hybrid Energy Systems, Emission, HOMER, NPC, LCOE

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# IMPLEMENTING "BUZZ LINES": MULTI-CRITERIA SPATIAL MODELING OF URBAN POLLINATOR HABITAT CONNECTIVITY AND RESTORATION PRIORITIES IN SARAJEVO

ABSTRACT 25 · ICENS 2026

**Adi Vesnic[a*], Lejla Smailagić Vesnić[a], Samir Đug[a]**

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**Abstract:**

Rapid landscape urbanization causes microclimatic fragmentation, isolating wild pollinators from vital nesting and foraging resources. To combat biodiversity loss, international frameworks like the Kunming–Montreal Global Biodiversity Framework (Target 12) and the EU Nature Restoration Law mandate biodiversity-inclusive spatial planning. This study operationalizes these benchmarks within Sarajevo's enclosed valley core (115.12 km²). We developed a cloud-native, traits-based spatial model to delineate ecological restoration priority zones and map interconnected insect corridors, termed "Buzz Lines," as an urban climate-adaptation blueprint.

Multi-spectral datasets from the 2025 blooming season (Sentinel-2 and Landsat-8) were processed in Google Earth Engine to model floral density (EVI), unsealed nesting substrates (NDVI), and topographic warmth. A Modified Normalized Difference Water Index (MNDWI) hydro-mask corrected thermal bleeding near the Miljacka River. Fragmentation and network morphometry were quantified in R using Connected Component Analysis (CCA) and thinning skeletonization algorithms.

Results show a robust baseline vegetation vigor (mean NDVI of 0.74), but built-up surfaces seal 47.39% of the core. Multi-criteria overlay allocated 42.95% of mature canopy to Class 1 (Conservation Core). Active restoration priorities were segmented across remaining surfaces: Class 2 (5.03%), Class 3 (1.45%), Class 4 (1.00%), and Class 5 (0.10%). Class 5 critical hotspots isolate degraded micro-grasslands on steep, high-temperature transit verges (>36.79°C). CCA revealed severe fragmentation, identifying 3,928 discrete patches (>0.1 ha) with a high density of 34.12 patches/km². Morphological skeletonization mapped a 29.17 km linear "Buzz Line" network spanning 2.93 km².

While Sarajevo's restorable territory (50.53%) exceeds the EU's 30% mandate, the high patch density confirms intense fragmentation. The primary east-west transit artery acts as a high-friction barrier, isolating northern sub-populations from southern alpine forests (Trebević). The 29.17 km centerline database provides a precise blueprint to modify mowing frequencies and establish pesticide-free flower strips. This reproducible framework ultimately strengthens Bosnia and Herzegovina's capacity for global biodiversity reporting and EU accession alignment.

**Keywords:** Nature Conservation, EU Nature Restoration Law, Kunming–Montreal Target 12, Biodiversity

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# CLIMATE CHANGE AND SOIL-PLANT NUTRIENT DYNAMICS: A REVIEW OF IMPACTS AND ADAPTIVE STRATEGIES

ABSTRACT 26 · ICENS 2026

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**Abstract:**

Climate change is exerting significant effects on soil fertility and plant nutrient cycles through rising temperatures, irregular precipitation patterns, and increasing atmospheric $CO_2$ concentrations. The literature reports that rising temperatures alter the rate of soil organic matter mineralization, affecting the bioavailability of essential macronutrients such as nitrogen, phosphorus, and potassium, while drought stress limits root development and thereby reduces nutrient uptake capacity. In addition, elevated $CO_2$ levels have been reported to increase photosynthetic rates (the "$CO_2$ fertilization effect"), but this is also associated with a nutrient dilution effect that lowers nitrogen and micronutrient concentrations in plant tissues, with the potential to adversely affect the nutritional quality of agricultural products. Soil microbial activity and enzymatic processes are also directly influenced by changes in temperature and moisture, which in turn alter processes such as nitrogen fixation, mycorrhizal symbiosis, and organic matter cycling. Secondary effects such as salinization, erosion, and soil structure degradation are reported to accelerate nutrient losses, particularly in arid and semi-arid regions. This review evaluates the direct and indirect effects of climate change on soil-plant nutrient dynamics within the context of soil physicochemical properties, microbial ecology, and plant physiology, based on current literature. As adaptation strategies, the literature frequently emphasizes the importance of precision fertilization, the development of stress-tolerant cultivars, organic matter management, and sustainable agricultural practices that support soil health. In conclusion, understanding the complex interactions between climate change, soil fertility, and plant nutrition is of critical importance for the sustainability of food security, and future research should address soil-plant-climate interactions in an integrated manner.

**Keywords:** Climate Change, Soil Fertility, Plant Nutrition, Nutrient Dilution, Soil Microbial Activity, Precision Fertilization, Sustainabl

# SEISMIC RESPONSE PREDICTION OF BILINEAR HYSTERETIC SYSTEMS USING A PHYSICS-INTEGRATED RECURRENT NEURAL NETWORK

ABSTRACT 27 · ICENS 2026

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**Abstract:**

Rapid prediction of nonlinear seismic response histories is important for assessing structural demands under earthquake excitation. Conventional nonlinear dynamic analysis can reproduce yielding behavior but becomes computationally demanding when numerous ground-motion records must be considered. This study presents a physics-integrated recurrent neural network (PiR-NN) for seismic response prediction of single-degree-of-freedom systems governed by bilinear hysteresis. The network advances the structural state recursively through three coordinated components. First, a Hysteretic Encoder constructed with bidirectional gated recurrent units extracts path-dependent features associated with loading, unloading, and yielding from the preceding response history. The encoded features are then combined with the current displacement, velocity, restoring force, and subsequent ground acceleration. Second, a residual-network-based Increment Predictor estimates the displacement and restoring-force increments at the next time step. Third, a Physics-Integrated Layer derives the corresponding velocity through the Newmark-β formulation, enforcing kinematic compatibility within the network architecture. The model is trained and evaluated using earthquake records selected from the PEER NGA-West2 database. The dataset contains 835 horizontal ground-motion components with moment magnitudes of 6.0–8.0, distances of 0-40 km, and V30 values of 180-760 m/s. Numerical results for a bilinear hysteretic oscillator show that PiR-NN reproduces the displacement, velocity, and restoring-force histories under previously unseen ground motions. The predicted hysteresis loops also capture the transition between the elastic and post-yield branches. These results support the use of physics-integrated recurrent learning as a surrogate for seismic response history analysis of bilinear hysteretic systems.

**Keywords:** Bilinear Hysteresis, Single-Degree-of-Freedom System, Nonlinear Seismic Response, Physics-Integrated Recurrent Neural Network

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# ANTIMICROBIAL PHOTODYNAMIC THERAPY AGAINST ANTIBIOTIC RESISTANCE: DETERMINING AN EFFECTIVE ANTIMICROBIAL APPROACH AGAINST MRSA AND E. COLI

ABSTRACT 28 · ICENS 2026

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**Abstract:**

Antibiotic resistance is a growing global health concern, highlighting the need for alternative and adjunctive antimicrobial strategies. This study investigated the antibacterial efficacy of antimicrobial photodynamic therapy (aPDT), antibiotics, and their combination against methicillin-resistant Staphylococcus aureus (MRSA) and Escherichia coli (E. coli). A boron-dipyrromethene (BODIPY)-based photosensitizer (PS), activated using a green light-emitting diode (LED) system at approximately 520 nm, was employed for photodynamic treatment. Vancomycin was used against MRSA, whereas ceftazidime was selected for E. coli. Bacterial cultures were standardized to a turbidity of 0.5 McFarland. Experimental groups included untreated control, light-only, PS-only, antibiotic-only, aPDT, and combined aPDT–antibiotic treatments. Following dark incubation with BODIPY, the designated aPDT groups were irradiated with green LED light. Antibacterial activity was assessed by serial dilution followed by colony-forming unit (CFU/mL) enumeration.

Against E. coli, aPDT resulted in an approximately 3-log reduction in bacterial viability. Ceftazidime concentrations below the $MIC_{50}$ did not produce a pronounced inhibitory effect, and combining aPDT with ceftazidime did not provide a clear additional antibacterial benefit compared with aPDT alone. In MRSA, vancomycin at concentrations of 0.7, 1.5, and 3 µg/mL produced concentration-dependent antibacterial effects without complete bacterial elimination. aPDT alone similarly resulted in an approximately 3-log reduction in bacterial viability. Notably, no detectable bacterial growth was observed following combined aPDT and vancomycin treatment, indicating complete bacterial elimination under the tested experimental conditions.

These findings demonstrate the antibacterial potential of BODIPY-based aPDT and indicate that its interaction with conventional antibiotics may depend on the bacterial species and antibiotic employed. In particular, the complete elimination of detectable MRSA following combined aPDT and vancomycin treatment supports further investigation of aPDT–antibiotic combination strategies as a potential approach against antibiotic-resistant bacteria.

**Keywords:** Antimicrobial Photodynamic Therapy, BODIPY, Photosensitizer, MRSA, E. coli, Antimicrobial Resistance

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# TRANSIENT 3D CFD ANALYSIS OF SQUEEZE FILM DAMPERS FOR DIFFERENT ECCENTRICITY RATIOS

ABSTRACT 29 · ICENS 2026

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**Abstract:**

Squeeze film dampers (SFDs) are widely used in high-speed rotating equipment to control rotor vibrations and prevent instability. Most design calculations still rely on the classical Reynolds lubrication theory. However, this classical approach ignores fluid inertia and struggles to capture real 3D flow behavior when operating conditions become severe. In this study, a 3D transient CFD model was developed in ANSYS Fluent to solve the full Navier–Stokes equations for a finite-length SFD. The whirling motion of the journal was applied at each time step using a custom User-Defined Function (UDF) combined with dynamic meshing. The investigation focused on evaluating the damper's dynamic pressure distribution across four distinct eccentricity ratios: ε=0.1,0.25,0.5, and 0.75. The results show that increasing eccentricity sharply amplifies hydrodynamic pressure, with the highest pressures developing right around the minimum film thickness at the damper midline. At lower values (ε=0.1 and 0.25), the pressure profiles remain relatively moderate and smooth. In contrast, at higher eccentricities (ε≥0.5), the fluid film experiences steep pressure spikes along with a noticeable forward shift in the pressure curve, caused by growing fluid inertia. Neglecting these inertia effects clearly leads to underestimating peak pressures and dynamic forces. Furthermore, this 3D CFD methodology reliably handles complex damper geometry, such as feeding grooves, holes, and end seals that are difficult to resolve using simplified analytical equations. Overall, this work shows that a 3D transient Navier–Stokes CFD approach provides a far more realistic evaluation of SFD behavior than traditional models, especially when dampers operate under large orbital motions.

**Keywords:** Squeeze Film Damper (SFD), Eccentricity Ratio, Fluid Inertia, Transient CFD, 3D Navier–Stokes, Pressure Distribution

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# DEVELOPMENT OF A HYBRID ACTUATION PLATFORM INTEGRATING A STEPPER MOTOR AND SOLENOID FOR FLOW REGULATION AND VALVE APPLICATIONS IN MICROFLUIDIC CHIPS

ABSTRACT 30 · ICENS 2026

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**Abstract:**

Remote and automated control of fluid actuation is increasingly desirable in microfluidic systems used for biomedical analysis, cell culture, and lab-on-a-chip applications, as it reduces manual intervention and enables integration with programmable or remotely operated experimental setups. However, conventional actuation and valve systems are often designed for specific functions, limiting their adaptability due to complex mechanical structures, high manufacturing costs, and low modularity. In this study, a microcontroller-based, pump-free modular microfluidic actuation platform was developed by integrating a stepper motor-driven brass screw mechanism for remotely controllable fluid displacement with an electromagnetic push-pull solenoid valve for microchannel opening and closing The system was designed using Autodesk Fusion 360 (version 2705.1.15). Chip-adapted components were fabricated by SLA-based resin 3D printing (Anycubic Photon Mono-X 6Ks MSLA). The stepper motor-driven screw generated direct push-pull forces at the chip inlet, enabling positive- and negative-pressure control. The automated operation of the stepper motor and solenoid valve were managed by a custom-designed drivicener board governed by a microcontroller. M3 brass screws were tested with compatible SLA-printed housings to optimize mechanical stability, sealing performance, and backlash during fluid displacement. The solenoid module controlled the opening and closing of the microchannel by applying force to a flexible Sylgard 184 polydimethylsiloxane (PDMS) membrane. PDMS mixing ratios of 3:1, 4:1, 5:1, 6:1, and 10:1 were evaluated for membrane performance. More elastic formulations showed irreversible deformation and misalignment, whereas the 3:1 ratio provided greater mechanical stability and more effective channel sealing during valve operation. The developed platform provides a modular and scalable approach for microfluidic flow control, offering broad adaptability for portable point-of-care and application-specific microfluidic systems. Furthermore, the microcontroller-based architecture will facilitate real-time parameter adjustments, ensuring dynamic and precise control over the microfluidic processes. In this work, the mechanical design, actuation performance, and application potential for automated microfluidic workflows will be discussed in detail.

**Keywords:** Microfluidics, Hybrid Actuation, Solenoid Valve, Stepper Motor Pump, 3D Printing, Lab-on-a-Chip

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# PILOT STUDY ON A LARGE LANGUAGE MODEL FOR CLASSIFICATION AND CORRECTION OF ARABIC LINGUISTIC ERRORS BY NATIVE TURKISH SPEAKERS

ABSTRACT 31 · ICENS 2026

**Ayşen Özün Türkçetin[a*], İrem Uslu[a]**

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**Abstract:**

The linguistic disparities between Turkish and Arabic can provide challenges for native Turkish speakers acquiring Arabic as a second language, especially in recognizing and comprehending various categories of linguistic mistakes. This preliminary work explores the capability of a large language model (LLM) to identify, rectify, and elucidate Arabic linguistic inaccuracies while assessing the impact of several prompting techniques on classification efficacy. A meticulously assembled pilot dataset of 60 Arabic mistake instances was classified into four distinct categories: phonetic, morphological, syntactic, and semantic, with 15 instances allocated to each group. GPT-OSS-120B underwent assessment across three prompting scenarios: zero-shot, definition-guided, and few-shot prompting. For every instance, the model was instructed to ascertain the main mistake classification, furnish a rectified Arabic sentence, and produce an educational elucidation in Turkish. The evaluation of classification performance was conducted by accuracy, macro-averaged precision, recall, F1-score, and confusion matrices. Definition-guided prompting attained the pinnacle of performance, registering an accuracy of 56.7% and a macro-F1 score of 0.549, in contrast to zero-shot prompting, which recorded an accuracy of 50.0% and a macro-F1 score of 0.456. Few-shot prompting attained an accuracy of 55.0% and a macro-F1 score of 0.539. Performance exhibited significant variability among different mistake categories. In the context of definition-guided prompting, morphological mistakes attained a recall rate of 86.7% and syntactic errors reached a precision of 87.5%, whereas phonetic errors proved to be notably difficult, exhibiting just 26.7% recall. The qualitative analysis also revealed instances where the model delivered a suitable remedy but categorizing the issue differently. The results indicate that direct language instruction can enhance mistake classification in LLMs, while also showing that error repair and metalinguistic classification are separate competencies. Additional investigation with more extensive, peer-reviewed datasets is essential to corroborate these first results.

**Keywords:** Arabic Language, Large Language Models, Error Analysis, Corrective Feedback, Natural Language Processing, Intelligent Tutor

# YOLO-BASED OBJECT LOCALIZATION FOR TURKISH–ARABIC VISUAL VOCABULARY LEARNING: A PILOT STUDY USING SNAPTATE AI

ABSTRACT 32 · ICENS 2026

**Ayşen Özün Türkçetin[a*], İrem Uslu[a]**

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**Abstract:**

Visual object detection offers opportunities to connect real-world objects with vocabulary learning; however, its application to Turkish–Arabic bilingual learning remains underexplored. This pilot study investigates the feasibility of integrating YOLO-based object localization into a mobile-assisted Turkish–Arabic visual vocabulary learning framework. A bilingual dataset comprising 184 annotated images was created using SnapTate AI (Advanced Image Annotation Tool), developed specifically for this study. The tool supports image acquisition, bounding-box annotation, and the assignment of corresponding Turkish and Arabic lexical labels, enabling the creation of bilingual visual vocabulary data. Since most lexical categories were represented by only one image, training a reliable multi-class lexical recognition model was not considered appropriate. Therefore, the detection task was formulated as class-agnostic object localization, with all annotated objects assigned to a single vocabulary_object class, while their Turkish–Arabic lexical labels were retained separately as bilingual metadata. The dataset was divided into 128 training, 37 validation, and 19 test images. A pretrained YOLO11n model was fine-tuned using transfer learning and data augmentation. On the held-out test set, the model achieved a precision of 0.994, recall of 1.000, mAP@50 of 0.995, and mAP@50–95 of 0.995. The findings demonstrate highly accurate localization of vocabulary-related target objects within the pilot dataset and support the feasibility of combining bilingual image annotation with YOLO-based localization for visual vocabulary learning. However, the results reflect object localization rather than recognition of individual lexical categories. Future research will expand the dataset with multiple images per lexical category and investigate automatic Turkish–Arabic lexical recognition and interactive vocabulary-learning activities.

**Keywords:** SnapTateAI, Turkish–Arabic Vocabulary Learning, YOLO11n, Object Localization, Mobile Learning, Computer Vision

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# DESIGN AND MANUFACTURING OF ARTIFICIAL COMPOSITE STONE USING WASTE LIMESTONE AND GLASS-BASED REINFORCEMENTS

ABSTRACT 33 · ICENS 2026

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**Abstract:**

Artificial composite stones have recently gained increasing attention as multifunctional materials for both civil engineering and defense applications. In this study, a novel com-posite stone was developed using waste limestone particles as the primary mineral filler, combined with unsaturated polyester (UP) resin and reinforced with 200 µm glass pow-der and chopped glass fibers with a length of 3.2 mm. Two resin ratios (25% and 30%) were examined to evaluate their influence on the physico-mechanical and microstructural behavior of the composites. Six different mixtures were produced and tested in accordance with TS EN 13755, TS EN 1926, and TS EN 14157 standards. Experimental investigations included atmospheric-pressure water absorption, uniaxial compressive strength, wide disc abrasion resistance, surface appearance change under acidic exposure, and optical microscopy analyses. The results indicate that the incorporation of fine fillers, particularly 200 µm glass powder, significantly enhances matrix densification, resulting in extremely low water absorption values (below 0.01% in some specimens) and improved compres-sive strength. Glass fiber–reinforced mixtures containing 3.2 mm chopped fibers exhibited higher load-bearing capacity compared with unreinforced formulations, confirming the effectiveness of short fiber reinforcement within the tested composite system. Abrasion re-sistance was found to be strongly influenced by resin content and particle packing densi-ty, while OM images revealed distinct differences in interfacial bonding quality and void morphology among the mixtures. Overall, the study presents a sustainable, lightweight, and structurally robust artificial composite stone with enhanced durability, mechanical performance, and environmental resistance, offering a promising material alternative for applications requiring long-term outdoor stability and camouflage compatibility.

**Keywords:** Artificial Composite Stones, Defense Camouflage Systems, Limestone

# PATTERN DISCOVERY IN NETWORK LAYERS: DATA MINING FOR DDOS ATTACK DETECTION

ABSTRACT 34 · ICENS 2026

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**Abstract:**

Denial of Service (DoS) or Distributed DoS (DDoS) attacks still stand as one of the most important challenges to network security today and results in serious network unavailability and large monetary loss all over the world. Discovering and neutralizing these attacks early is important. This paper discusses the use of various data mining algorithms to identify DDoS attack through identifying patterns in various network layers. It's notable that classification techniques have been used such as Naïve Bayes, Support Vector Machines (SVM), K-Nearest Neighbors (KNN), and Random Forest. The analysis is achieved using the intelligent data mining tool; Jupyter Notebook using Python, emphasizing a good preprocessing stage and a coherent pattern recognition model. It is found that RF and KNN yield relatively high accuracy, which indicates that the methods are suitable for detection regarding the attack patterns in networks. This study highlights the importance of intelligent data mining methods in strengthening cybersecurity and proposes practical solutions for efficient DDoS detection.

**Keywords:** DDoS Attack Detection, Data Mining, Random Forest, K-Nearest Neighbors (KNN), Classification, Cybersecurity

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# HEART DISEASE DIAGNOSIS PREDICTION WITH CART DECISION TREES AND NAÏVE BAYES ALGORITHM

ABSTRACT 35 · ICENS 2026

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**Abstract:**

Cardiovascular diseases are one of the primary groups of diseases causing mortality worldwide. This makes early diagnosis detection vital for appropriate treatment methods. This research concerns the use of intelligent software systems to predict heart disease on the Cleveland Heart Disease dataset. After preprocessing the data by cleaning, normalizing, and categorical conversion, it was used to train and test different classification models. Specifically, Decision Tree classifiers based on Gini index and entropy criteria, along with Naive Bayes Gaussian classifier, were implemented. Testing and comparison of the models were made in terms of accuracy, precision, recall, and F1-score. Among these, the Naïve Bayes Classifier came out best in balanced terms of recall and precision for detecting positive cases of heart disease. Hence, the outcome shows that the prediction of heart disease is possible even with some simpler models. This project further shows the utility of data mining techniques in medical diagnostics, thus backing their integration into clinical decision-support systems.

**Keywords:** Heart Disease Prediction, Naïve Bayes, Decision Tree, Data Mining, Classification, Medical Diagnosis, Intelligent Software Syste

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# DIGITAL REGISTRIES AND ADMINISTRATIVE HEALTH DATA FOR INFLAMMATORY BOWEL DISEASE SURVEILLANCE: CASE DEFINITIONS, DATA LINKAGE AND DATA QUALITY

ABSTRACT 36 · ICENS 2026

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**Abstract:**

Population-based surveillance is essential for understanding the changing epidemiology of inflammatory bowel disease (IBD), planning health services and monitoring treatment safety. Several high-income countries conduct such surveillance using national patient registries, clinical quality registers and health administrative databases, whereas many countries, including Türkiye, still lack a national IBD registry. This short review aims to describe the methodological foundations of registry-based and administrative data-based IBD surveillance and to derive lessons for countries without such systems. A narrative review of methodological and population-based studies published up to September 2026 was conducted, with emphasis on Canada, Denmark, Sweden, the United States and the United Kingdom. Three methodological pillars were identified. First, validated case definitions that combine diagnostic codes, health-care contacts and medication dispensing identify IBD in administrative data with high accuracy. Second, deterministic linkage through unique personal identification numbers, or probabilistic linkage where these are unavailable, allows hospital, prescription, pathology and mortality records to be combined at the individual level. Third, systematic assessment of data conformance, completeness and plausibility, together with transparent reporting under the REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) statement, underpins valid inference. These systems have produced long-term incidence trends, prevalence forecasts and pharmacovigilance evidence that hospital-based studies cannot provide. Türkiye already has a national personal identification number, a nationwide electronic health record platform and centralised reimbursement data, which together provide a foundation for a validated, privacy-preserving national IBD surveillance system. Developing such a system should be a public health priority.

**Keywords:** Administrative Data, Inflammatory Bowel Disease, Medical Record Linkage, Public Health Surveillance, Registries

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# PLANT-BASED NATURAL COLORANTS FOR LEATHER FOOTWEAR: DYEING PERFORMANCE, ANTIBACTERIAL ACTIVITY AND COLOR FASTNESS

ABSTRACT 37 · ICENS 2026

**Gulnur Nayetova[a], Bekzhan Abzalbekuly[a], Farkhad Tashmukhamedov[a], Nilay Örk Efendioğlu[b*], Ersin Onem[b], Hüseyin Ata Karavana[b]**

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**Abstract:**

Lining leather is a critical component in footwear requiring adequate mechanical performance, hygiene and durability. This study explores an eco-friendly dyeing approach for sheepskin leather using plant-based colorants derived from Calligonum aphyllum, oak bark and Rubia tinctorum. In response to the environmental impact of synthetic dyes in leather colorisation, natural alternatives were evaluated in terms of colorimetric, mechanical and antibacterial properties. The results showed that both individual and combined extracts produced a wide range of color shades while enhancing functional performance. Notably, the combination of Rubia tinctorum and oak bark exhibited superior tensile strength (29.4 MPa) and the highest color intensity (K/S = 1.464). Whole dyed leathers demonstrated antibacterial activity, with Rubia tinctorum yielding the largest inhibition zone (up to 4 mm). The microscopic analysis of the cross-sectional morphology of the dyed leather demonstrated that the penetration depth of the natural dyes ranged from 12% to 65% of the leather thickness. The dyed leather samples exhibited good dry rubbing fastness, with color fastness ratings ranging from 3/4 to 4/5 according to the grey scale, indicating satisfactory fixation of the natural colorants. This variation reflects differences in the diffusion behaviour and affinity of the plant-based colorants towards the collagen matrix. These findings indicate that plant-based dyes can improve both the structural integrity and hygienic performance of leather, highlighting their potential as sustainable alternatives in footwear lining applications.

**Keywords:** Natural Colorants, Leather, Footwear, Dyeing, Color Fastness

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