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2024

2nd Chemical Research Conference
Kavala Students

BOOK
OF
ABSTRACTS

KAVALA CAMPUS JUNE 6

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CHEMICAL RESEARCH CONFERENCE KAVALA STUDENTS

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ABSTRACTS

2nd Chemical Research Conference of Kavala Students

GRAND HALL, KAVALA CAMPUS ● JUNE 6 2024

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FORWARD

Dear Colleagues,

2nd Chemical Research Conference of Kavala Students (2CRC-KS) is an endeavor of the Department of Chemistry of Democritus University of Thrace to introduce research-driven education to undergraduate students. Following the great success of the 1st Chemical Research Conference of Kavala Students (1CRC-KS), which was held on June 8th, 2023, the initiative continues to inspire and engage students in research activities. The first event demonstrated the effectiveness of integrating research into the chemistry curriculum, making it the first of its kind in Greece. The positive outcomes strongly support the continuation of this approach.

The 2nd CRC-KS took place on June 6th, 2024, at the Grid Lab of our University at Kavala Campus. This year conference featured 23 participant groups, totaling 87 students, who presented 6 oral and 17 poster presentations over a span of 4 hours. The students' work was of exceptionally high standards, with some contributions being remarkably innovative and intriguing. Topics covered all areas of Chemistry: Physical, Organic, Inorganic, Analytical, Biochemistry, Chemical Technology, and Material Science.

Both the supervisors and the students greatly benefited from the experience, exchanging ideas with colleagues and reinforcing their enthusiasm for incorporating research into their future academic and professional pursuits. As in the previous edition, the works will be reviewed by two referees, necessary corrections will be suggested, and the final articles will be included in the Conference Proceedings Book of Abstracts, which will be available on the Chemistry Department's website (www.chem.duth.gr).

The Conference Organizing Committee would like to congratulate and thank all participants for their contributions to 2CRC-KS, ensuring another successful event that fosters a strong research culture among undergraduate students.

On behalf of the Organizing Committee

Prof. A. Ch. Mitropoulos
Dpt. of Chemistry, Democritus University of Thrace

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DEVELOPMENT OF A HYBRID WATER-SOLUBLE PORPHYRIN-CARBON DOT MATERIAL AS PHOTOTHERAPEUTIC AGENT

S. Chouliaras, S. Eginloglou, M. Katsanopoulou, C. Tsamtzidou,
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Photodynamic therapy (PDT) is a noninvasive cancer treatment with fewer side effects than chemotherapy, radiotherapy, and immunotherapy. It uses a photosensitizer (PS) activated by light and oxygen to produce reactive oxygen species (ROS) that kill targeted cells. Porphyrins, common PSs, are favored for their high quantum yield and low toxicity, but their low water solubility and tendency to aggregate are limitations. To overcome these issues, researchers are integrating PSs with nanomaterials like silica, iron, gold nanoparticles, and carbon-based materials. Carbon dots (CDs), a new type of carbon nanomaterial, are particularly promising due to their excellent optical properties, high water solubility, low toxicity, biocompatibility, cell permeability, and ease of modification. CDs are being explored for applications in bioimaging, theranostics, optoelectronics, and sensing.[1] Porphyrins are heterocyclic macrocycle compounds found in hemoglobin, cytochromes, and plant photosynthesis. Recently, they've been used in sensing, photocatalysis, light harvesting, and photothermal therapy. Their red-emissive fluorescence is useful for biological imaging, but they lack photostability and suffer from self-quenching. Combining porphyrins with photostable carbon molecules can improve their stability.[2]

The aim of the present project is to combine a porphyrin-carbon dot complex in order to synthesize a novel water-soluble porphyrin-carbon dot hybrid material as a phototherapeutic agent for cancer treatment. This approach presents the advantage of easy preparation of the compounds and the combination of their advanced photocatalytic properties towards their anticancer activity (*Figure 1*).

Initially, **TPP-$(COOCH_3)_4$** was synthesized by reaction of 4 equivalents of pyrrole with 4 equivalents of benzaldehyde, in the presence of propionic acid under reflux for 1 hour. After cooling down the reaction mixture to room temperature, purple crystals were afforded. Then, the purple solid was isolated by filtration under vacuum in order to obtain 0.622 g of **TPP-$(COOCH_3)_4$** in 10.34 % yield. Subsequently, hydrolyzed porphyrin **TPP-$(COOH)_4$** was synthesized by reacting 103 mg of **TPP-$(COOCH_3)_4$** in THF:MeOH in a 2:1 ratio and 2.78 g of KOH dissolved in 48 ml H_2O, under reflux for two days. The reaction mixture was distilled in a rotary evaporator to remove the solvents and then acidified with HCl to pH 3.10, filtered under vacuum to obtain 0.100 g of precipitate in 97.09 % yield. The compounds **TPP-$(COOCH_3)_4$** and **(TPP-$(COOH)_4$** were characterized with TLC, where their Rf values were calculated and compared to literature values, UV-Vis spectroscopy in order to determine their molecular absorbance (ε), and FT-IR to observe characteristic vibration peaks. The carbon dots were synthesized through hydrothermal treatment. The reaction was carried out in an autoclave where an equivalent of both ethylenediamine and citric acid were dissolved in ultrapure water at pH = 12.10. The autoclave was heated at 180 °C for 8 hours in an oven and allowed to reach room temperature overnight. The mixture was then centrifuged once for 30 minutes at 4 000 rpm and then filtered with an osmosis membrane of 1 KDa to remove unreacted starting material. Then the water was removed with a freeze dryer and the product NCDs was isolated as a red powder. The material was characterized by UV-Vis, FT-IR, SEM and Nano-Sight techniques (*Figure 1*). The hybrid **NCDs@TPP-$(COOH)_4$** was synthesized in a similar way, simply by adding 1.0047g **TPP-$(COOH)_4$** to the initial mixture in the autoclave.

Following the successful synthesis and characterization of **NCDs@TPP-$(COOH)_4$** and **NCDots**, their photodegradation was researched upon visible light irradiation. Each substance was diluted in ultra-pure water in quartz cuvettes and irradiated with a 100 W white LED light. The samples were set up in a closed space with the light source placed 15 cm away. In order to monitor the photodegradation, UV-Vis spectra were obtained every 10 minutes. The light irradiation stopped when the absorbance value showed no significant change. The λ_{max} of each substance was recorded and the data were illustrated in *Figure 3*.

Overall, during this work an efficient photocatalyst **NCDs@TPP-$(COOH)_4$** was prepared. All synthesized molecules and final composites were characterized with UV-Vis, FT-IR and SEM methods (*Figures 2,4*). The hybrid material exhibited photo induced degradation ~ 25 % due to enhanced ROS generation ability of **NCDs@TPP-$(COOH)_4$** photosensitizer. In order to clarify this issue, further monitoring of the singlet oxygen generation should be performed. On the other hand, NCDs exhibited a lower self-degradation process (almost 13 % lower). Our future work includes the estimation of photodynamic therapeutic efficiency of the hybrid photosensitizer as well as the performance of cytotoxicity essays before and after PDT treatment.

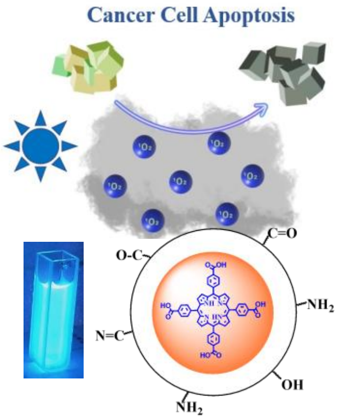

Figure 1. Schematic representation of self-degradable photosensitizer for photodynamic therapy.

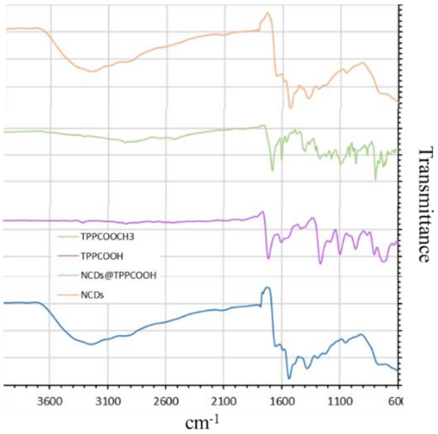

Figure 2. FT-IR spectra of all prepared compounds.

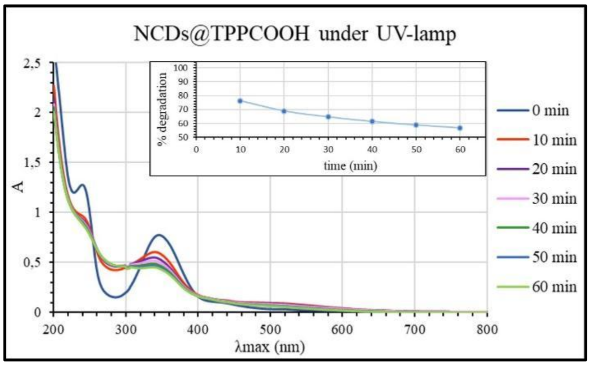

Figure 3. Absorbance's degradation percentage of the hybrid material over time.

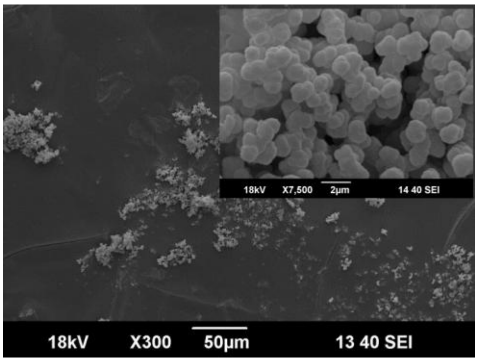

Figure 4. SEM images of **NCDs@TPPCOOH**.

Key-words: Porphyrins, carbon dots, photocatalytic reaction, phototherapeutic agent.

Acknowledgements: The authors would like to thank Dr. K. Ladomenou for her supervision.

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ΑΝΑΠΤΥΞΗ ΕΝΟΣ ΥΒΡΙΔΙΚΟΥ ΥΔΑΤΟΔΙΑΛΥΤΟΥ ΥΛΙΚΟΥ ΠΟΡΦΥΡΙΝΗΣ-ΝΑΝΟΤΕΛΕΙΩΝ ΑΝΘΡΑΚΑ ΩΣ ΦΩΤΟΘΕΡΑΠΕΥΤΙΚΟΣ ΠΑΡΑΓΟΝΤΑΣ

Η φωτοδυναμική θεραπεία (PDT) είναι μια μη επεμβατική θεραπεία του καρκίνου, χρησιμοποιεί φωτοευαισθητοποιητές (PS) που ενεργοποιούνται από το φως για την παραγωγή δραστικών ειδών οξυγόνου (ROS) που θανατώνουν τα καρκινικά κύτταρα. Οι πορφυρίνες, κοινές PS, έχουν περιορισμούς όπως η χαμηλή διαλυτότητα στο νερό. Έτσι, οι ερευνητές συνδυάζουν PS με νανοϋλικά. Οι τελείες άνθρακα (CD) είναι πολλά υποσχόμενες λόγω της υδατοδιαλυτότητάς τους και της βιοσυμβατότητάς τους. Στην παρούσα εργασία συντέθηκε ένα νέο υβριδικό υλικό **NCDs@TPP-(COOH)$_4$** *για τη θεραπεία του καρκίνου. Το υλικό χαρακτηρίστηκε με UV-Vis, FT-IR, SEM και παρουσίασε φωτοσταθερότητα κατά την φωτοβόληση του με λάμπα LED. Οι μελλοντικές μελέτες θα αξιολογήσουν τη θεραπευτική του αποτελεσματικότητα και την κυτταροτοξικότητά του.*

EVALUATION OF BIOACTIVES' CONTENT AND ANTIOXIDANT CAPACITY OF AVOCADO BY-PRODUCTS

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Avocado by-products are agri-food bio-wastes with increased environmental footprint and waste management cost. However, they contain valuable compounds of lipid nature that if appropriately valorized as ingredients in other novel products, including functional cosmetics and foods, they can enhance their bio-functionality and their health benefits. Bioactive compounds of lipid nature that remain in avocado waste include the amphiphilic polar lipids, phenolics and carotenoids that possess antioxidant activities against oxidative stress and associated disorders [1]. The objective of the present study was to quantify the content in lipophilic and amphiphilic bioactives (i.e. carotenoids and phenolics, respectively) of avocado by-products' lipid extracts, as well as to evaluate their antioxidant capacity, along with their structural elucidation.

The total lipids (TL) were extracted from by-products of organic Cretan Hass avocados and further separated into extracts containing the total lipophilic compounds (TLC) and the total amphiphilic compounds (TAC), in which their content in phenolics, carotenoids and their antioxidant activities were quantified according to Tsoupras et al [2], based on gallic acid equivalent (GAE), carotene equivalent (CE) and the 2,2-diphenyl-1-picrylhydrazyl (DPPH) and 2,2′-azinobis-(3-ethylbenzothiazoline-6-sulfonic acid) (ABTS) bioassays, respectively, while their structural elucidation was performed by attenuated total reflectance (ATR) FTIR spectroscopy [3]. All reagents (Folin-Ciocalteu, DPPH, ABTS), solvents (chloroform, methanol, petroleum ether, ethanol, n-octane, isopropanol), phenolics (trolox, gallic acid, quercetin, catechin) and lipid standards (soy polar lipids, β-carotene) were purchased from Sigma Aldrich (St Louis, Missouri, US). UV-Vis spectroscopy analyses were performed in a LLG-uniSPEC 2 Spectrophotometer and ATR-FTIR spectroscopy in a Perkin Elmer Frontier ATR/FT–NIR/MIR spectrometer.

The avocado by-products' TAC extracts showed higher phenolics' content (285.96 – 703.48 mg GAE g^{-1} extract), in comparison to their carotenoids' content (12.11 - 89.07 mg CE g^{-1} extract), while similar outcomes were also found for the phenolics' and carotenoids'contents of the TLC extracts too (58.77 – 89.74 mg GAE g^{-1} extract, and 1.21 – 3.90 mg CE g^{-1} extract, respectively) (Figures 1 and 2). Subsequently, the TL extracts of avocado by-products showed a higher phenolics' content too than their carotenoids' content, suggesting that the avocado by-products are rich in more amphiphilic bioactives like phenolics, rather than in more lipophilic bioactives like carotenoids. With respect to the antioxidant capacity of both the TAC and TLC extracts of the avocado by-products, only the TAC extracts showed potent antioxidant activities at the DPPH assay, with IC_{50} values ranging from 143.99 to 633.76 mg mL^{-1} and Trolox equivalent (TE) antioxidant capacity (TEAC) values ranging from 0.02 to 0.11. In contrast, by applying the ABTS-based bioassay, such a potent antioxidant capacity was observed in both TAC and TLC extracts, with ABTS values ranging between 1.32 and 25.08 μmol TE × g^{-1} dry weight (DW) of extract. Nevertheless, this assay also showed that the amphiphilic TAC extracts possess more potent antioxidant activities. The differences observed in the outcomes obtained by the two different assays may be attributed to the different types of free radicals being scavenged by the TAC and/or TLC antioxidant bioactives, and/or to implications in the DPPH assay due to the presence of carotenoids that highly absorb light of similar λ (nm) to that applied in the assay.

The ATR FTIR structural analysis based on comparable fingerprint regions to those of assessed known standards, also exhibited that the extracts with amphiphilic compounds contained indeed specific phenolic bioactives, such as hydrolysable tannins like Gallic acid and highly bioactive flavonoids like the flavan-3-ol Catechin (similar peaks to standards, at ≈3300 cm^{-1} (O-H), ≈2950 cm^{-1} (C-H) and ≈1700 cm^{-1}), as well as bioactive polar lipids (similar peaks with standards at ≈2922 cm^{-1}, ≈2858 cm^{-1} and ≈1729 cm^{-1}), but also carotenoids (similar peaks with standard at ≈2927 cm^{-1} (C-H) and ≈1721 cm^{-1} (extended. -C═C-)).

Overall, within the present study several antioxidant bioactives were identified and quantified in the avocado by-products' extracts (mostly amphiphilic phenolics with potent antioxidant capacity, which further suggests that avocado by products are sustainable natural sources of such antioxidants that can be valorized as ingredients in several bio-functional products with health promoting properties, in a circular economy design.

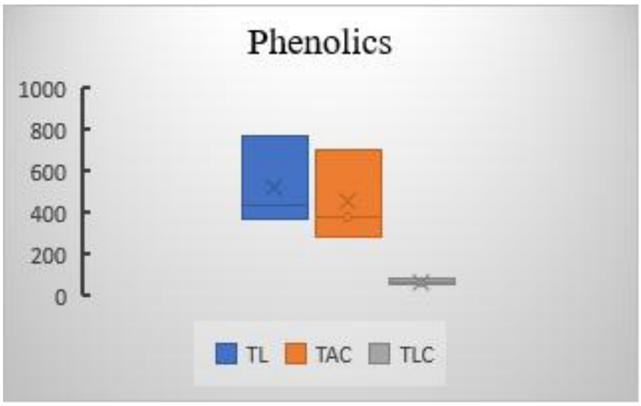

Figure 1. Phenolics' content of avocado by-products lipid extracts (mg of gallic acid equivalent (GAE) of phenolics per g of extract).

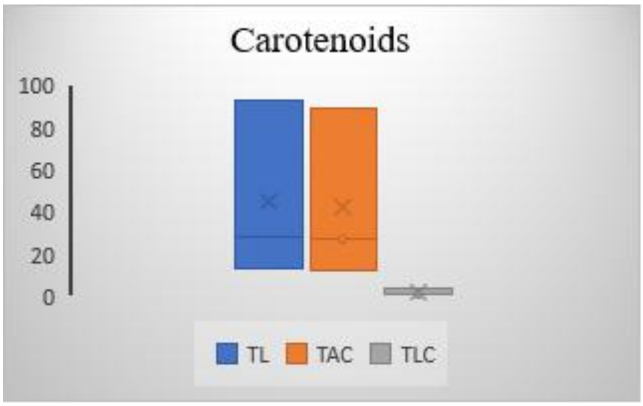

Figure 2 Carotenoids' content of avocado by-products lipid extracts (mg of carotene equivalent (CE) per g of extract).

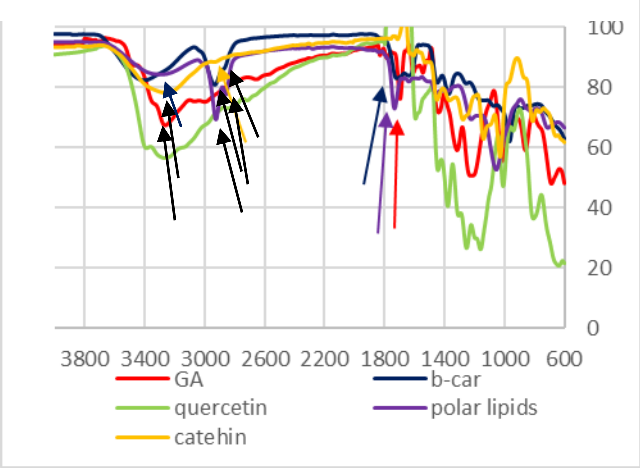

Figure 3 ATR-FTIR spectra of standards of phenolics (Gallic acid, quercetin, catehin), β-carotene, and soy polar lipids (Y-axis is %Transmittance and X-axis is cm^{-1})

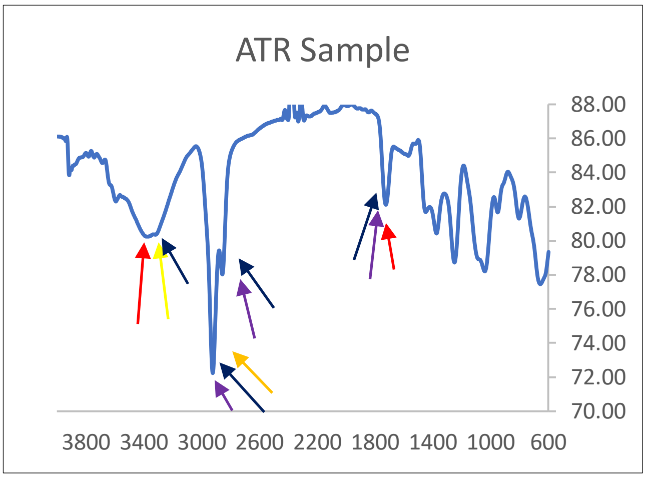

Figure 4 ATR-FTIR spectra of the most bioactive avocado by-products extract rich in amphiphilic bioactives. (Y-axis is %Transmittance and X-axis is cm^{-1})

Acknowledgements: The authors would like to thank their supervisor (PI), Ass. Prof. A. Tsoupras, as well as Ass. Prof. N. Vordos, Dr. A. Ofrydopoulou and Ms. K. Marra for their continuous support.

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ΑΞΙΟΛΟΓΗΣΗ ΤΗΣ ΠΕΡΙΕΚΤΙΚΟΤΗΤΑΣ ΣΕ ΒΙΟΔΡΑΣΤΙΚΑ ΣΥΣΤΑΤΙΚΑ ΚΑΙ ΤΗΣ ΑΝΤΙΟΞΕΙΔΩΤΙΚΗΣ ΙΚΑΝΟΤΗΤΑΣ ΠΑΡΑΠΡΟΪΟΝΤΩΝ ΤΟΥ ΑΒΟΚΑΝΤΟ.

Τα παραπροϊόντα του αβοκάντο περιέχουν πολύτιμα βιοδραστικά συστατικά λιποειδικής φύσεως. Η παρούσα μελετη είχε στόχο τον ποσοτικό προσδιορισμό τέτοιων βιοδραστικών ενώσεων με αντιοξειδωτική δράση από τα βιο-απόβλητα του αβοκάντο ως πιθανά βιολειτουργικά συστατικά για καινοτόμα προϊόντα (καλλυντικά και τρόφιμα) που προάγουν την υγεία. Βρέθηκε ότι αυτά τα παραπροϊόντα είναι πλούσια πηγή φαινολικών βιοδραστικών (440 mg GAE g^{-1} extract), αλλά και καροτενοειδών (28 mg CE g^{-1} extract), που ανιχνεύτηκαν κυρίως στα αμφίφιλα εκχυλίσματα τους. Τα αποτελέσματα αυτά συνάδουν με την ισχυρή αντιοξειδωτική δράση που παρατηρήθηκε κυρίως στα εκχυλίσματα αμφίφυλων συστατικών των παραπροϊόντων του αβοκάντο, και επιβεβαιώθηκαν περεταίρω με ποιοτικό δομικό χαρακτηρισμό με ART-FTIR αυτών των εκχυλισμάτων, όπου ανιχνεύτηκαν και οι δύο τάξεις αυτών των βιοδραστικών συστατικών που μελετήθηκαν, σύμφωνα με ανάλυση και πρότυπων ουσιών. Τα υποσχόμενα αποτελέσματα αυτής της μελέτης προάγουν την αξιοποίηση παραπροϊόντων αβοκάντο ως βιώσιμη πηγή αντιοξειδωτικών βιοδραστικών που μπορούν να χρησιμοποιηθούν σε προϊόντα με οφέλη για την Υγεία, στα πλαίσια κυκλικής οικονομίας.

e-Presentation

THE EFFECT OF NANOBUBBLES ON THE DIFFUSION OF INK FRACTALITY

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Nanobubbles (NBs) are gaseous cavities that have sizes around 200 nm. According to Young-Laplace's equation they shouldn't exist for more than a few ms; however, they do exist for weeks, even months. Although a full thermodynamic or a non-equilibrium thermodynamic analysis has not been developed yet, industry uses NBs in many processes in order to intensify them. Nanobubbles are classified to surface and bulk NBs. The existence of surface NBs has already been proven by an atomic force microscope. The existence of bulk NBs is a subject of intense debate among the scientific community; one reason being that NBs and nanoparticles conclude to the same detecting results [1]. He and Qian have studied the diffusion process of red ink in saline water. They have concluded for the fractal dimension of pure water D = 1.92 [2]. Zhou et al. have also studied the penetration of red ink in saline water. They have suggested a zig-zag curve linking for the water lattice that explains the selected penetration of the ink [3].

In this study, we have prepared 12 solutions with and without NBs as follows: 3 solutions of plain deionized water (DIW), 3 solutions of DIW with NBs, 3 solutions of NaCl (10% w/v) with DIW and 3 solutions with DIW/NaCl/NBs. A drop of blue ink is allowed to sink within solutions and their track was recorded. The time required for the ink blob to reach the bottom of the beaker, in the case of the above-mentioned various solutions [2], along with the conductivity of the solutions measured with a Paar conductometer. Data analysis of the results is conducted in the frame of fractal geometry. The relation between the perimeter (P) of the area (a) of the ink blob was estimated by using the image processing and analysis in Java [4] and the fractal dimension D was calculated by: $P=KA^{D/2}$ where K is a proportionality constant.

Figure 1 shows the fractal analysis. In the case of plain water D=1 indicating the smoothness of the drop. In the case of DIW/NBs D=1.3 indicating the formation of a fractal perimeter. A similar D=1.4 is given in the case DIW/NaCl too. In the case of DIW/NaCl/NBs, D=1.9. The result is in an excellent agreement with a quadric Koch Island of fractal dimension between 1.6 and 1.7. That is, a finite pinch of energy spreads a square ink blob around. Then the original eddy splits into smaller scale eddies, the effect of which are more local.

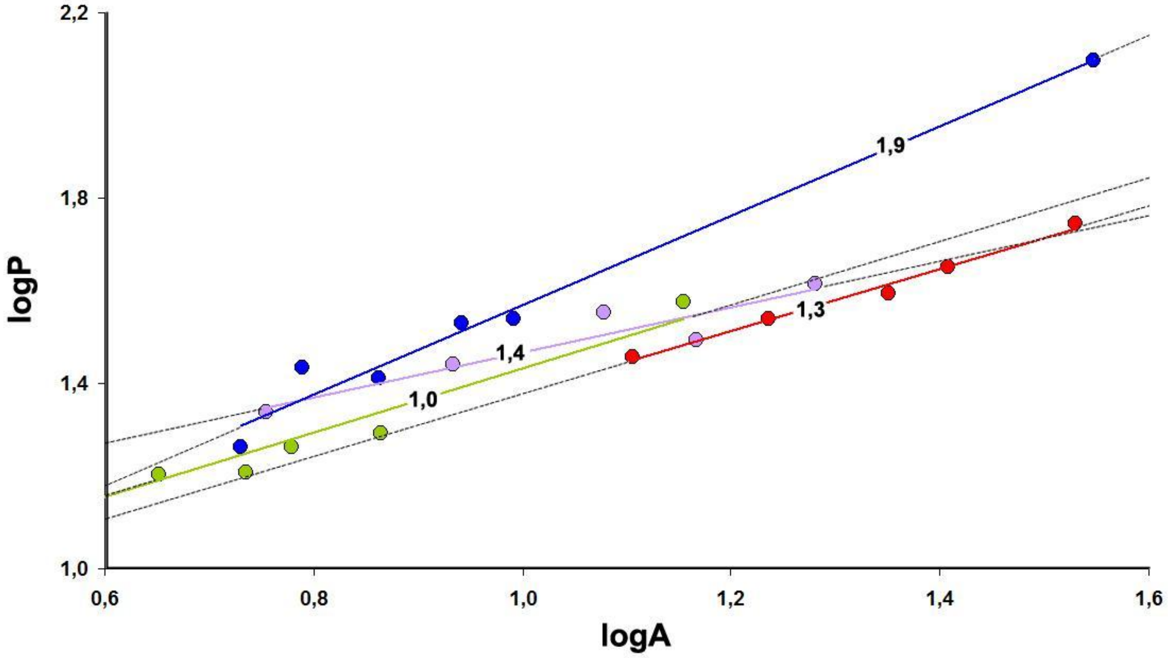

Fig. 1 Fractal dimensions for various ink solutions. Violet line and dots DIW, D = 1; Red line and dots DIW/NBs, D = 1.3; Green line and dots DIW/NaCl, D = 1.4; and Blue line and dots DIW/NBs/NaCl, D = 1.9.

Figure 2 shows snapshots of ink in plain water, DIW/NBs, DIW/NaCl and DIW/NBs/NaCl. Different solutions show a different cascade fall. Plain water follows a quick drop of 13.5 s to the bottom of the beaker. DIW/NBs and DIW/NaCl produce different cascade falls for the same drop time (~23 s). DIW/NBs/NaCl has a rather large drop time of 87.2 s. Contour lines indicate an ellipsoid fall for the case without NBs and a circular fall for the case with NBs. The combination of salt with NBs creates constrictions within the paths of DIW that increase the buoyancy effect on the y-axis and a spread on the x-axis, NBs delaying the cascade fall.

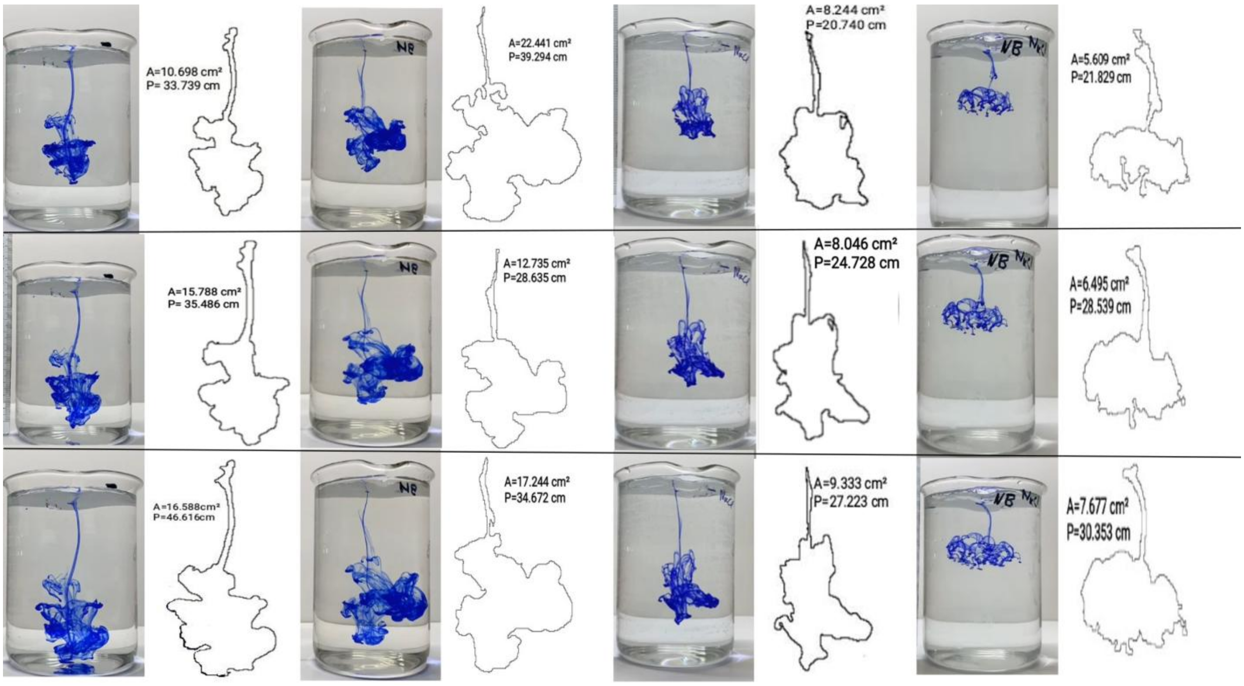

Fig. 2 Snapshots and contour lines of ink cascade fall for different solutions. Left column: DIW; upper frame 9 s drop and area to perimeter A/P=11/34, middle frame 12.5 s and A/P=16/35, bottom frame 15 s and A/P=17/47. Middle left column: DIW/NBs; upper frame 9 s drop and A/P=22/39, middle frame 12.5 s and A/P=13/29, bottom frame 15 s and A/P=17/35. Middle right column: DIW/NaCl; upper frame 9 s drop and A/P=8/21, middle frame 12.5 s and A/P=8/25, bottom frame 15 s and A/P=9/27. Right column: DIW/NBs/NaCl; upper frame 9 s drop and A/P=6/22, middle frame 12.5 s and A/P=6/29, bottom frame 15 s and A/P=8/30.

Acknowledgements : The authors would like to thank Dr. A. Mitropoulos and Dr. R. Kosheleva for their supervision.

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[4] ImageJ, imagej.net.ij.

Η ΕΠΙΔΡΑΣΗ ΤΩΝ ΝΑΝΟΦΥΣΑΛΙΔΩΝ ΣΤΗ ΜΟΡΦΟΚΛΑΣΜΑΤΙΚΟΤΗΤΑ ΔΙΑΧΥΣΗΣ ΤΗΣ ΜΕΛΑΝΗΣ

Οι νανοφυσαλίδες (NBs) αμφισβητούν την εξίσωση Young-Laplace, ωστόσο χρησιμοποιούνται ευρέως στη βιομηχανία. Αυτή η μελέτη διερευνά NBs σε υδατικά διαλύματα με και χωρίς NaCl. Παρασκευάστηκαν δώδεκα διαλύματα: DIW, DIW/NBs, DIW/NaCl και DIW/NBs/NaCl. Στιγμιότυπα από την κίνηση μιας σταγόνας μπλε μελάνης σε αυτά τα διαλύματα απεικονίστηκαν. Η μορφοκλασματική γεωμετρία του περιγράμματος αυτών εκτιμήθηκε από το λόγο της επιφάνειας προς την περιφέρεια. Τα αποτελέσματα έδειξαν ότι το DIW παρήγαγε μια ομαλή περίμετρο πτώσης μελάνης D=1, ενώ το DIW με NBs έδειξε μια μορφοκλασματική περίμετρο D=1.3. Παρόμοιες διαστάσεις μορφοκλασματικότητας παρατηρήθηκαν για το DIW/NaCl D=1.4. Στην περίπτωση του DIW/NaCl/NBs, D=1.9. Τα ευρήματα υποδηλώνουν ότι οι NBs και το NaCl προκαλούν μορφοκλασματικά χαρακτηριστικά σε διαλύματα, ενισχύοντας την άνωση και τη διασπορά της μελάνης, με διαφορετικούς, ωστόσο μηχανισμούς.

e-Presentation

SYNTHESIS AND CHARACTERIZATION OF EMULSIONS WITH LIPID NANOPARTICLES FOR TRANSDERMAL DELIVERY OF RETINOL AND HYALURONIC ACID

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Introduction

Lipid nanoparticles (LNPs) are a class of nanoscale particles (1 to 1000 nm) primarily composed of lipids and have shown great success in the pharmaceutical and cosmetic industries.[1] Their success is attributed to the precise delivery of active compounds to specific sites within the body, enhancing therapeutic efficacy, protecting actives from degradation, and ensuring a longer shelf-life. Additionally, they promote sustained drug release, increasing the bioavailability of lipophilic drugs and facilitating the delivery of drugs through transdermal routes.[2] Hyaluronic acid (HA) is a widely utilized ingredient in the cosmetic industry, renowned for its exceptional hydrating and anti-aging properties. Retinol, a derivative of vitamin A, is also another highly regarded ingredient in the cosmetic industry, particularly known for its powerful anti-aging and skin-renewing properties.[3] However, HA and retinol encounter significant obstacles in penetrating the skin barrier because of their large molecular size and lipophilic nature, respectively. In this work, we overcome this challenge, encapsulating HA and retinol in LNPs synthesized by chitosan (CS) and lecithin (LC). Then, the prepared LNPs were incorporated into the oil in water (O/W) emulsions.

Experimental method

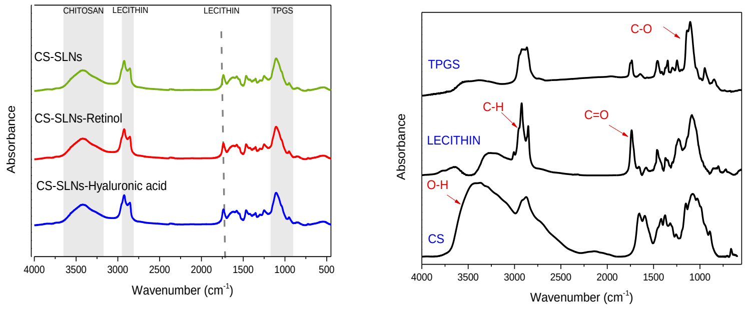
For the preparation of the LNPs, CS was dissolved in water with acetic acid, while TPGS (d-α-tocopheryl polyethylene glycol 1000) and LC were dissolved in ethanol. The two solutions were then mixed in a 20:1 ratio (LC:CS). To create the O/W emulsions, two separate solutions were prepared: the water phase (70%), containing water and glycerin, and the oil phase (30%), containing shea butter, almond oil, and phytocream. Both mixtures were heated to 70°C, and the oil phase was gradually added to the water phase to form a homogeneous emulsion. Then, the prepared LNPs were added in emulsions to produce Em-NPs-HA and Em-NPs-Retinol. Additionally, an emulsion without LNPs (Blank) and emulsions with dispersed HA and retinol were prepared to compare the results (Em-Retinol and Em-HA). The prepared lipid nanoparticles (LNPs) and emulsions containing LNPs were then evaluated for their physicochemical properties and their efficiency in delivering HA and retinol transdermally (ex vivo).

Results

The successful synthesis of LNPs was confirmed via FTIR measurements. The characteristic peaks of CS, LC, and TPGS were observed in LNPs spectra. Additionally, the spectra of the NPs with encapsulated active retinol and HA (CS-SLNs-RETINOL and CS-SLNs-HA) are almost identical to the spectra of the corresponding empty CS-SLNs NPs (fig. 1a and b), indicating the successful encapsulation of actives in the NPs. The SEM image confirmed the formation of uniform CS-SLNs NPs with a well-formed spherical structure with an average size of about ~600 nm (calculated using ImageJ software) (fig. 1c).

The prepared emulsions presented enhanced pH, and viscosity stability as well as they avoided phase separation after the use of centrifugation. However, it was found that the addition of LNPs and active substances slightly increased the viscosity and pH of the emulsion (fig 2). The transdermal delivery and release of HA and retinol were investigated using Franz cells and UV/VIS SPECTROPHOTOMETERS. It was found that the LNPs increased the permeability of the active substances to the simulated human body fluids and the HA presented enhanced release efficiency due to its hydrophilic nature compared to lipophilic retinol (fig 3).

(a)



(b)

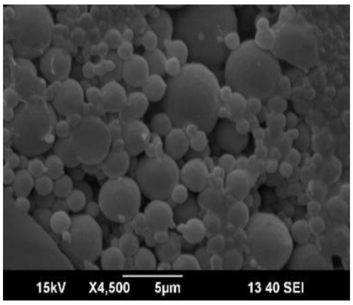


Figure 1. a) FTIR spectra b)SEM image of CS-SLNs

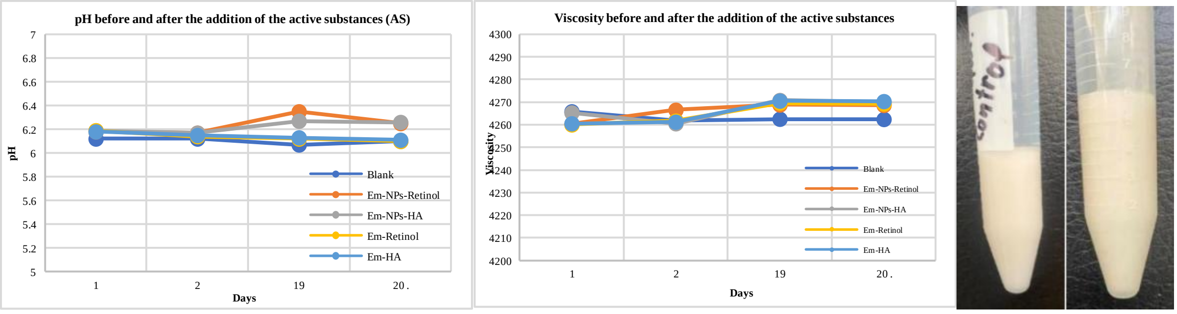


Figure 2. a) pH and b) viscosity, c) phase separation study

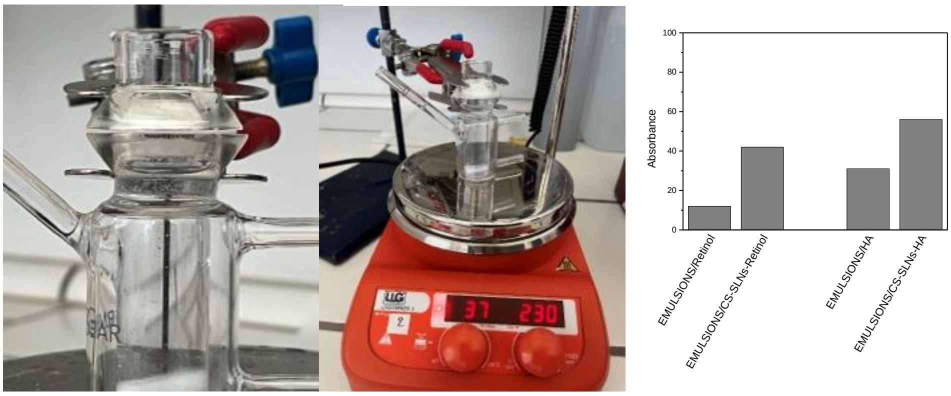


Figure 3. Ex vivo study of delivery and release efficiency of HA and retinol

Aknowledgements: The authors would like to thank Dr.G.Kyzas & Dr.I. Koumentakou for their supervision.

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ΣΥΝΘΕΣΗ ΚΑΙ ΧΑΡΑΚΤΗΡΙΣΜΟΣ ΓΑΛΑΚΤΩΜΑΤΩΝ ΜΕ ΛΙΠΙΔΙΚΑ ΝΑΝΟΣΩΜΑΤΙΔΙΑ ΓΙΑ ΔΙΑΔΕΡΜΙΚΗ ΧΟΡΗΓΗΣΗ ΡΕΤΙΝΟΛΗΣ ΚΑΙ ΥΑΛΟΥΡΟΝΙΚΟΥ ΟΞΕΟΣ

Η παρούσα εργασία στοχεύει σε ένα προηγμένο σύστημα διαδερμικής χορήγησης υαλουρονικού οξέος και ρετινόλης στις κατώτερες στιβάδες του δέρματος με την χρήση της νανοτεχνολογίας και των γαλακτωμάτων για εφαρμογές στην κοσμητολογία. Συγκεκριμένα, κατασκευάστικαν λιπιδικά νανοσωματίδια από βιοπολυμερές χιτοζάνη και λεκιθίνη στα οποία ενθυλακώθηκαν υαλουρονικό οξύ και ρετινόλη. Τα παρασκευασμένα νανοσωματίδια προστέθηκαν σε φυσικά, λάδι σε νερό (Λ/Ν) γαλακτώματα. Τα νανοσωματίδια καθώς και τα γαλακτώματα με και χωρίς την προσθήκη των νανοσωματιδίων μελετήθηκαν ως προς τις φυσικοχημικές τους ιδιότητες και την ικανότητα χορήγησης και απελευθέρωσης των δραστικών συστατικών στο εσωτερικό του ανθρώπινου οργανισμού. Τα αποτελέσματα απέδειξαν την επιτυχή σύνθεση των νανοσωματιδίων, την αυξημένη σταθερότητα των γαλακτωμάτων καθώς και την προηγμένη ικανότητα των νανοσωματιδίων να διαπεράσουν τον δερματικό φραγμό και να απελευθερώσουν τις δραστικές ουσίες από το εσωτερικό τους.

e-Presentation

USE OF RECYCLED AND SPECIALLY PROCESSED EXPANDED POLYSTYRENE AS AGGREGATE MATERIAL IN CEMENT MORTAR: STUDY OF MECHANICAL AND THERMAL PROPERTIES

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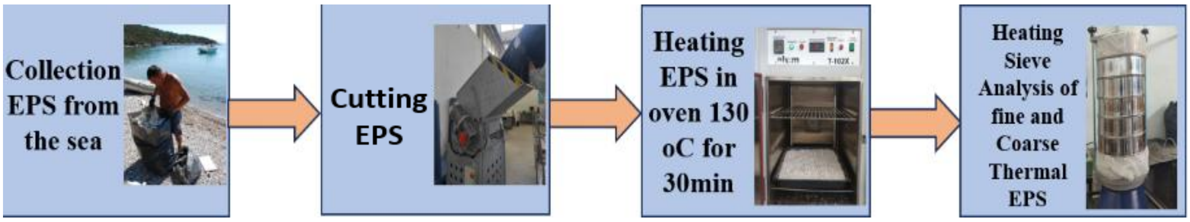
Every year approximately 23 million tons of plastic waste leaks into aquatic ecosystems, polluting lakes, rivers and seas. A major source of marine plastic waste is expanded polystyrene (EPS)– a type of plastic that is lightweight, buoyant and waterproof. In addition, the construction sector has a significant impact on the environment due to the major quantities of aggregates used in the production of concrete. Aggregates are a broad category of materials used in construction, including sand and gravel. The increased consumption of sand as an aggregate has led to the depletion of existing resources. Sand is being depleted faster than it can be replenished that has resulted to global and local shortages [1].

EPS is an inert, hydrocarbon-containing, highly thermally insulating, moisture resistant and low thermally conductive thermoplastic material with low density that is stable in the presence of most chemicals [2]. Recycling is one way to reduce the amount of EPS in the ocean and the pollution caused by this material. Therefore, recycled expanded polystyrene becomes an interesting choice for use as lightweight aggregate to replace natural sand.[1] Studies have shown the possibility of using EPS as an environmentally friendly alternative for the partial replacement of sand in mortar [3]. However, there are still some knowledge gaps regarding the use of EPS as a substitute for natural sand in cementitious materials [4]. In this study, a novel method was developed to process EPS waste collected from the Aegean archipelago. The thermally processed EPS was used as an aggregate in cement mortar matrix substituting sand by 50 and 100%. The mechanical properties (compressive and flexural strength), the thermal properties and the density of the developed composites were investigated.

The materials used to prepare the thermal EPS mortars included: (a) Portland cement CEM II 42.5 N, (b) natural river sand, (c) water, (d) thermally treated EPS and (e) superplasticizer GR 120. The EPS waste was collected for the sea, cut using a special granulator, thermal treated at 130^{o}C for 30 min and sieved (Figure 1).

Figure 1. EPS processing flow chart



Collection EPS from the sea

Cutting EPS

Heating EPS in oven 130 oC for 30min

Heating Sieve Analysis of fine and Coarse Thermal EPS

Three mortar mixtures were prepared to evaluate the impact of thermal EPS as a lightweight aggregate. A reference mixture without thermal EPS, and mixtures with 50% and 100% of thermal EPS replacing sand by volume, respectively. The mortar mixtures composition was according to the EN196-1 standard. A total of nine (9) specimens having dimensions of 40x40x160mm were produced from each mixture for flexural and compressive strength tests and density determination. Additionally, two (2) specimens of 205x205x50mm were prepared from each mixture to be used for thermal conductivity measurements. The flexural performance of the mortars was evaluated through three-point bending tests conducted at 7 and 28 days using an electromechanical VTS 10kN machine according to ASTM C 293-02 with a displacement rate of 0.2 mm/min. After the flexural tests, the compressive strength of the mortar was assessed on half prisms, according to the EN196-1 standard, using a closed-loop servo-hydraulic MTS 25 kN testing machine with a displacement rate of 0.2 mm/min. Finally, thermal conductivity was measured using a Laser Comp Fox 200HT device according to the BS EN 12667 standards for temperature differences of 20°C and 40°C, and the density of the mortar was measured according to ASTM C642.

The mechanical properties (compressive strength and flexural strength), thermal properties (thermal conductivity coefficient) and density results of the reference mortar (0%) and mortars with thermal EPS over sand substitution levels of 50 and 100%, are depicted in Figure 2 (a), (b), (c) and (d), respectively. The limits according to RILEM for the material to be characterized as structural (Class I), structural and insulating (Class II) and insulating (Class III) with regards to the compressive strength, thermal conductivity coefficient and density are shown in the graphs.

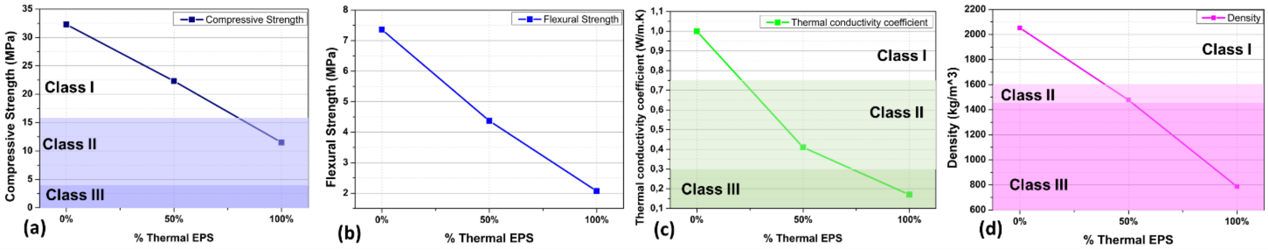


Figure 2. Diagrams (a) Compressive strength (b) Flexural strength (c) Thermal conductivity (d) Density in relation to Thermal EPS

It is observed that there is a linear correlation between the content of thermal EPS and the measurements, whether in mechanical properties, thermal properties, or density. Specifically, a 28% reduction in material density was observed with a 50% replacement of thermal EPS, and a 65% reduction with a 100% replacement of thermal EPS, while the corresponding reduction in the thermal conductivity coefficient (λ) was 59% and 83%, respectively. The mechanical properties showed a decrease due to the fact that EPS has lower mechanical properties compared to sand. It is interesting that despite the reduction observed, mortar with 50% content of thermal EPS is suitable for structural applications.

In conclusion, mortar with 50% content of Thermal EPS can be classified as lightweight due to weight reduction, having a low thermal conductivity coefficient, making it suitable as construction material with very good insulating properties. On the other hand, mortar with 100% content of thermal EPS is classified as an insulating material that demonstrates improved compressive strength that could be also suitable for construction.

Aknowledgements: The authors would like to thank Dr. Z. Metaxa and V. Prokopiou for their supervision and their help during the execution of this project. Many thanks to Dr. E. Apostolidou for providing us access to the renewable energy sources laboratory equipment.

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ΧΡΗΣΗ ΑΝΑΚΥΚΛΩΜΕΝΗΣ ΚΑΙ ΕΙΔΙΚΑ ΕΠΕΞΕΡΓΑΣΜΕΝΗΣ ΔΙΟΓΚΩΜΕΝΗΣ ΠΟΛΥΣΤΕΡΙΝΗΣ ΩΣ ΑΔΡΑΝΕΣ ΥΛΙΚΟ ΣΕ ΚΟΝΙΑΜΑ: ΜΕΛΕΤΗ ΤΩΝ ΜΗΧΑΝΙΚΩΝ ΚΑΙ ΘΕΡΜΙΚΩΝ ΙΔΙΟΤΗΤΩΝ

Η ρύπανση από πλαστικό, και συγκεκριμένα από το φελιζόλ, αποτελεί το 90% όλων των θαλάσσιων υπολειμμάτων, καθώς είναι βασικός μοχλός απώλειας της βιοποικιλότητας και υποβάθμισης των οικοσυστημάτων, ενώ συμβάλλει και στην κλιματική αλλαγή. Σημαντικό πρόβλημα, επίσης, αποτελεί η αλόγιστη χρήση αδρανών υλικών και ειδικότερα της άμμου, με αποτέλεσμα η συνεχής εξόρυξή της να απειλεί όλο και περισσότερο τους ζωικούς οργανισμούς. Στην παρούσα εργασία πραγματοποιήθηκε έρευνα σχετικά με τις μηχανικές και θερμικές ιδιότητες της ανακυκλωμένης από την θάλασσα και θερμικά επεξεργασμένης (EPS), ως μια φιλική προς το περιβάλλον εναλλακτική λύση για τη μερική και ολική αντικατάσταση της άμμου σε κονιάματα. Βρέθηκε ότι με τη μερική (50%) και ολική (100%) αντικατάσταση της άμμου από θερμικά επεξεργασμένο EPS μπορούν να αναπτυχθούν ελαφροβαρή κονιάματα με εξαιρετικές μονωτικές ιδιότητες.

e-Presentation

INVESTIGATION OF FACTORS AFFECTING PURCHASE INTENTION TOWARDS GREEN COSMETICS AMONG GEN Z CONSUMERS IN GREECE

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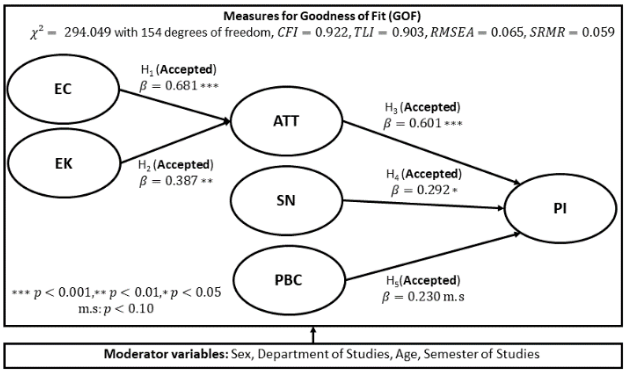
The Cosmetics Industry constitutes a dynamic and rapidly evolving market that was valued at approximately $565 billion in 2023, whereas it is expected to exceed $800 billion by 2027, worldwide. Apart from other key trends that drive the growth of this industry, there is an imperative demand for Green Cosmetics that promote sustainable and eco-friendly practices to ensure both consumer health and environmental protection [1]. The shift toward "sustainability beauty" is also considered a key driver for ensuring the loyalty of the Generation Z (Gen Z) consumers, since a plethora of surveys have reported that (a) Gen Z constitutes a major part in the growth of the industry and (b) Gen Z consumers have declared that they would be more willing to pay more for sustainable products, due to the fact that they value sustainability and ethical practices highly. From the consumer's point of view, however, there are many factors that may affect the decision to buy Green Cosmetic products and for this reason, there has been noted a growing research interest on the identification and understanding of these determinants [2].

Recognizing the research gap in investigating the above research trend, the motivation of the present study was the examination of the effect of factors on the intention of purchasing Green Cosmetics among Greek consumers, with a strong focus on tertiary students and young people belonging to Gen Z. To meet our objectives and based on the *Theory of Planned Behaviour* (TPB), a questionnaire-based cross-sectional survey was designed in order to collect data that were used, in turn, for the investigation of the posed research hypotheses (Figure 1). The instrument consisted of two sections that comprises a set of (a) demographic questions and (b) items aiming at measuring the six constructs of the study based on previous research attempts. The instrument consisted of 27 items measuring the following constructs: *Environmental Knowledge* (EK) (five items) [3], *Environmental Concern* (EC) (five items) [4], *Attitude* (ATT) (four items) [3], *Subjective Norm* (SN) (four items) [4], *Perceived Behavioural Control* (PBC) (five items) [5] and *Purchase Intention* (PI) (four items) [5] measured on five-points Likert scale, with anchors ranging from "*Strongly disagree*" to "*Strongly agree*".



The demographic profile of the 216 respondents indicates that 30.1% were male, 68.5% female, while 1.4% did not declare their Sex. The vast majority (90.2%) of the respondents were students and young people that belong to Gen Z, whereas 9.8% of them were above the age of 30. In terms of their educational background, 87.3% and 5.6% were under-graduate and graduated students, respectively, whereas 60.6% of the respondents were either under-graduate or graduated students from chemistry or other related to chemistry departments. In order to assess the fit of the proposed measurement model, we made use of *Confirmatory Factor Analysis* (CFA). Following the recommended best practices for the evaluation of the reliability, convergent and discriminant validity of the CFA model [6], we decided to exclude, through an iterative process, items that presented standardized factor loadings less than 0.50. The reliability of the measurement model was assessed through *Cronbach's alpha* (a) and *Composite Reliability* (CR) indices suggesting satisfactory levels of internal consistency for all items that exceeded the threshold value of 0.70 ($a \geq 70$). The fit indices of the hypothesized model indicated an acceptable fit to the data, $\chi^2 = 294.049$ with 154 degrees of freedom, $CFI = 0.922$, $TLI = 0.903$, $RMSEA = 0.065$ (90% CI $[0.054, 0.076]$), $SRMR = 0.059$[1] (Figure 1). All standardized factor loadings were statistically significant ($p < 0.001$) ranging from 0.561 to 0.938 indicating a strong relationship between the observed variables and their respective constructs [6].

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[1] CFI stands for *Comparative Fit Index*, TLI for *Tucker-Lewis Index*, RMSEA for the *Root Mean Square Error of Approximation*, and SRMR for the *Standardized Root Mean Square Residual*

The convergent validity was assessed via the *Average Variance Extracted* (AVE) indicator and the findings revealed that four (EC, ATT, SN, PI) out of six constructs presented values greater than the cut-off level of 0.50 (they explained more than 50% of the total variance). For the cases of EK and PBC, the AVE measures were higher than 0.4 but they were still considered acceptable, since their CR indicators were higher than 0.6 and thus, convergent validity was achieved for each examined construct [6]. Finally, the estimated factor correlations showed that none of the pairwise comparisons among the six constructs was significantly higher than the threshold value of 0.80 providing sufficient empirical evidence for discriminant validity.

Structural Equation Modeling (SEM) was conducted to investigate the hypothesized relationships between the latent constructs (Figure 1). The path coefficient between EC and ATT ($\beta = 0.681$, $p < 0.001$) indicated a statistically significant positive effect of EC on ATT supporting H_1. This also holds for the path coefficient between EK and ATT ($\beta = 0.387, p = 0.005$) supporting H_2. ATT revealed a statistically significant positive effect on PI ($\beta = 0.601, p < 0.001$) confirming H_3. Additionally, SN presented a statistically significant positive effect on PI ($\beta = 0.292, p = 0.013$) providing sufficient empirical evidence for accepting H_4. Finally, the path coefficient between PBC and PI presented a p-value that is higher than the alpha level of 0.05 but still significant at $a = 0.10$ ($\beta = 0.230, p = 0.088$). Summarizing the above findings, the path analysis signified that ATT is the most important factor affecting PI as indicated by the highest standardized coefficient followed by SN and PBC, whereas the effect of EC on ATT can be considered as more important compared to the corresponding effect of EK on ATT. Finally, *Multiple Group Analysis* (MGA) were performed to investigate the moderator effects of demographic variables on any path of the model. The findings showed that for under-graduated students, there was a statistically significant moderating effect of Semester of Studies on the relationship between EK and ATT. In this regard, the path coefficient for under-graduated students of the 1st and 2nd was significantly higher ($\beta = 0.856, p < 0.001$) compared to the insignificant path coefficient of respondents studying in higher semesters ($\beta = 0.317, p = 0.061$).

Acknowledgements: The authors would like to thank Dr. N. Mıttas for his supervision.

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ΔΙΕΡΕΥΝΗΣΗ ΠΑΡΑΓΟΝΤΩΝ ΠΟΥ ΕΠΙΔΡΟΥΝ ΣΤΗΝ ΠΡΟΘΕΣΗ ΑΓΟΡΑΣ ΠΡΑΣΙΝΩΝ ΠΡΟΙΟΝΤΩΝ ΚΟΣΜΗΤΙΚΗΣ ΤΩΝ ΚΑΤΑΝΑΛΩΤΩΝ ΤΗΣ ΓΕΝΙΑΣ Ζ ΣΤΗΝ ΕΛΛΑΔΑ

Η Βιομηχανία Καλλυντικών αποτελεί έναν δυναμικό και ταχέως αναπτυσσόμενο βιομηχανικό κλάδο αιχμής στον οποίο υπάρχει επιτακτική ζήτηση για βιώσιμα προϊόντα με φυσικά και πράσινα συστατικά ώστε να διασφαλιστεί τόσο η υγεία των καταναλωτών όσο και η προστασία του περιβάλλοντος. Παράλληλα, οι λήπτες αποφάσεων της βιομηχανίας καλούνται να προσελκύσουν τους καταναλωτές της Γενιάς Ζ καθώς μελέτες αναφέρουν ότι αποτελεί σημαντικό μέρος της ανάπτυξής της, με καταναλωτές, οι οποίοι δηλώνουν πρόθυμοι να πληρώσουν μεγαλύτερο αντίτιμο για Πράσινα Προϊόντα Κοσμητικής. Στην παρούσα εργασία διερευνώνται παράγοντες που επηρεάζουν την Πρόθεση Αγοράς Πράσινων Προϊόντων Κοσμητικής από τους Έλληνες καταναλωτές, με έμφαση στους καταναλωτές της Γενιάς Ζ. Βασιζόμενοι στην Θεωρία Προσχεδιασμένης Συμπεριφοράς διεξήχθη έρευνα μέσω ηλεκτρονικού ερωτηματολογίου και τα δεδομένα που συλλέχθησαν αναλύθηκαν με κατάλληλες μεθόδους πολυμεταβλητής στατιστικής ανάλυσης (Επιβεβαιωτική Ανάλυση Παραγόντων και Δομικά Μοντέλα Εξισώσεων) ώστε να αναδειχθούν οι παράγοντες που επιδρούν στην Πρόθεση Αγοράς Πράσινων Προϊόντων Κοσμητικής.

e-Presentation

AMPHIPHILIC AND LIPOPHILIC ANTIOXIDANT BIOACTIVES OF NATIVE GREEK AND IMPORTED SHRIMP SPECIES

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Marine sources, including shrimps, seem to be a rich source of antioxidant and anti-inflammatory bioactives [1]. The objective of this study was to evaluate the total content in carotenoids and phenolics and the antioxidant activity and structural activity relationship of lipid extracts from samples of three Greek shrimp species (*Melicertus kerathurus* and *Parapenaeus longirostris* from the Thracian Sea *and Aristeomorphea foliacea* from Rhodes) compared to those of an imported specie (*Litopenaeus vannamei* from the Indian Ocean), all of which were obtained from the Fisheries Research Institute (FRI) at Nea Peramos, Kavala, Greece.

Standards of phenolics (Gallic acid, quercetin, catechin), soy polar lipids, β-carotene, reagents of 6-hydroxy-2,5,7,8-tetramethylchroman-2-carboxylic acid (Trolox), 2,2-Diphenyl-1-picrylhydrazy (DPPH) and 2,2′-azinobis-(3-ethylbenzothiazoline-6-sulfonic acid) radical cation decolorization (ABTS) assay kits, and solvents (methanol, chloroform, n-octane, ethanol, isopropanol, petroleum ether) were obtained from Sigma Aldrich (St. Louis, Missouri, US). The LLG-uniSPEC 2 UV-Vis spectrophotometer was used for all spectrophotometric quantifications. Structural analyses were performed in a Perkin Elmer Frontier ATR/FT–NIR/MIR spectrometer.

The extracts of the total lipids (TL) were obtained from all samples and further separated into their total lipophilic and amphiphilic contents (TLC and TAC, respectively), according to Tsoupras et al. [2]. In all extracts, the total carotenoid and phenolic contents were quantified and expressed as carotenoid equivalent (CE) and Gallic Acid Equivalent (GAE) per gram of extract, respectively, and the total antioxidant activity was also evaluated as previously described [2], by both the DDPH and the ABTS bioassays, using Trolox as the standard and thus expressed as Trolox equivalent (TE) antioxidant capacity (TEAC) and ABTS values (μmol TE / g of extract). ATR-FTIR spectra analyses for structural elucidation were performed according to Vordos et al [3].

Carotenoids were mostly detected in the TLC extracts of all shrimp species in comparable amounts, and much less in their TAC extracts. Phenolics were detected only in the TAC extracts of all shrimp species, with the Thracian shrimp species (*M. kerathurus* and *P. longirostris*) showing comparable phenolic content with that of the imported shrimp (*L. vannamei*). Both TAC and TLC extracts of all shrimps showed antioxidant capacity to scavenge free radicals based on the DPPH assay, with the two Greek native shrimps grown in the Thracian sea (*M. kerathurus* and *P. longirostris*) displaying comparable TEAC antioxidant capacity to that of the imported specie. Similar outcomes were obtained from the ABTS assay in TAC extracts too, whereas much higher antioxidant activities were found in the TLC of Indian shrimp. ATR-FTIR analysis of the TAC extracts exhibited that all shrimp species contain polar lipids, and marine phenolics, including flavonols and hydrolysable tannins in TAC and β-carotene. Overall, these promising results outline the antioxidant potency of bioactives of Thracian shrimps, which were comparable to that of a well-known imported specie rich in lipid bioactives.

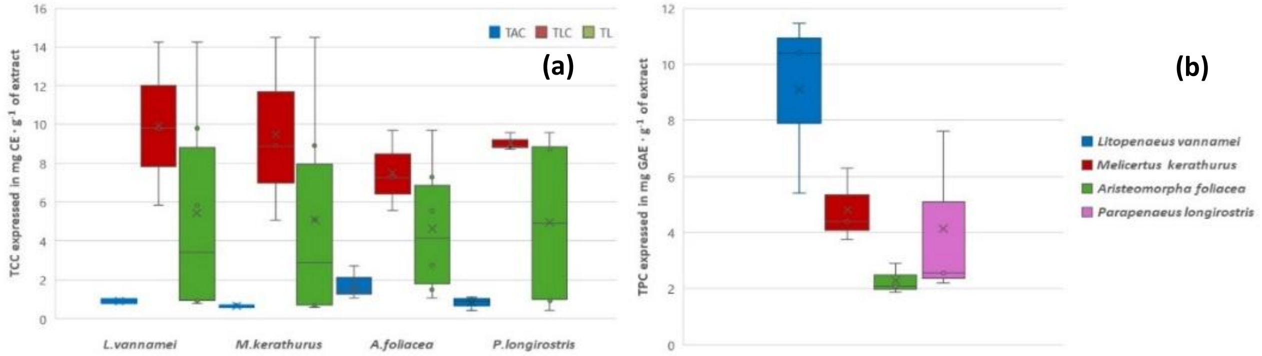

Figure 1 Total carotenoid (**a**) and phenolic (**b**) contents expressed as mg of CE and mg of GAE per g of extract, respectively, for the TAC, TLC and TL extracts of all shrimp samples.

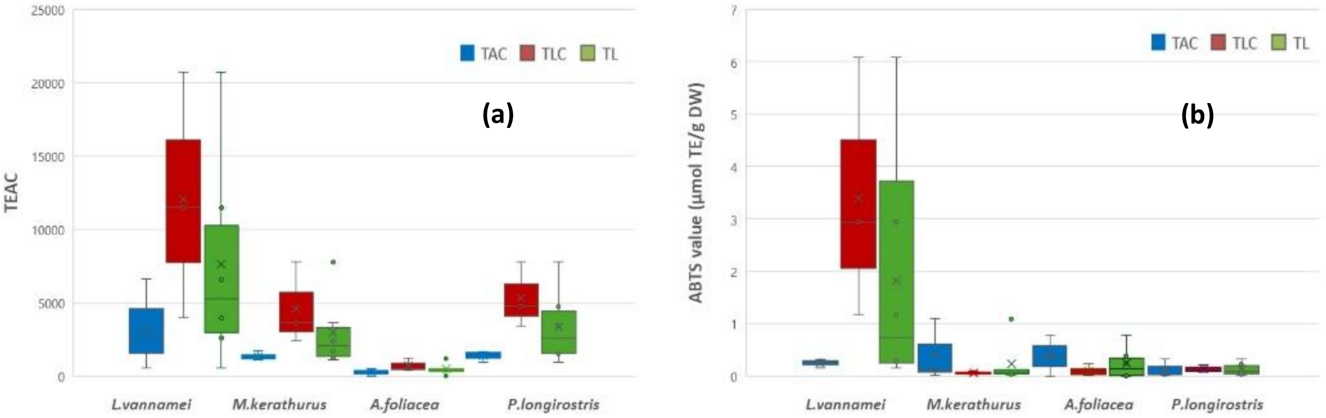

Figure 2. Antioxidant capacity for the TAC, TLC and TL extracts of all shrimp samples expressed as Trolox equivalent (TE) antioxidant capacity (TEAC) based on the DPPH assay (**a**) and as ABTS values (μmol TE/g of dry weight) based on the ABTS assay (**b**), respectively.

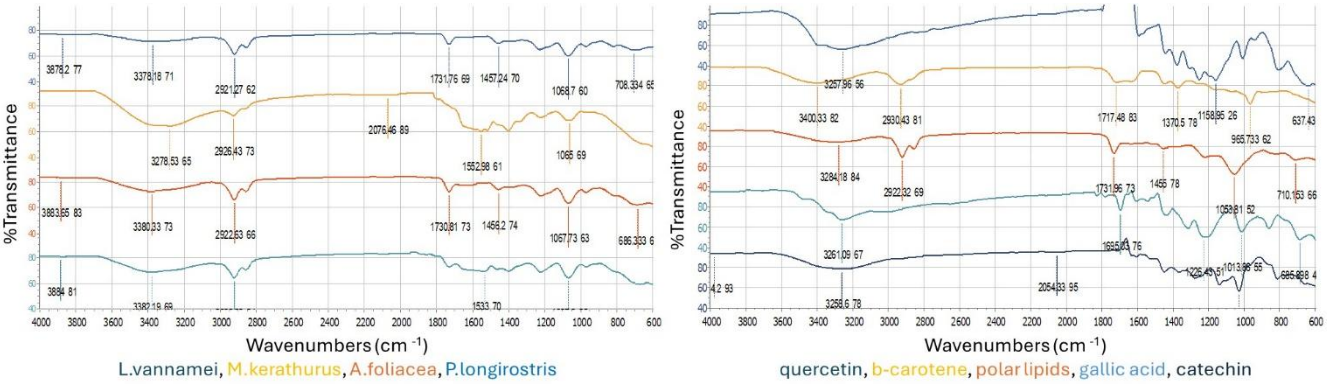

Figure 3 ATR-FTIR spectra of TAC extracts of all shrimp samples (left), as well as of standard phenolics (quercetin, gallic acid, catechin), carotenoids (β-carotene) and soy polar lipids (right)

Acknowledgements: The authors would like to thank their supervisor (PI) Assist. Prof. A. Tsoupras, as well as Ass. Prof. N. Vordos, Dr. A. Ofrydopoulou, Dr. C. Anastasiadou (FRI) and Ms. E. Galouni for their continuous support.

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ΑΜΦΙΦΙΛΑ ΚΑΙ ΛΙΠΟΦΙΛΑ ΑΝΤΙΟΞΕΙΔΩΤΙΚΑ ΒΙΟΔΡΑΣΤΙΚΑ ΣΕ ΓΗΓΕΝΗ ΕΛΛΗΝΙΚΑ ΑΛΛΑ ΚΑΙ ΕΙΣΑΓΟΜΕΝΑ ΕΙΔΗ ΓΑΡΙΔΑΣ

*Εδώδιμα θαλάσσια είδη, όπως οι γαρίδες περιέχουν βιοδραστικά συστατικά λιποειδικής φύσεως. Ο σκοπός της παρούσας μελέτης ήταν η σύγκριση της περιεκτικότητας και δομής βιοδραστικών ουσιών (καροτενοειδή, φαινολικά), καθώς και οι αντιοξειδωτικές ιδιότητες των λιπιδιακών εκχυλισμάτων από τρία ελληνικά είδη γαρίδας (*M. kerathurus *και* P. longirostris *από το Θρακικό Πέλαγος και* A. foliacea *από τη Ρόδο) σε σύγκριση με ένα εισαγόμενο είδος (*L. vannamei *από τον Ινδικό Ωκεανό) πλούσιο σε αντιοξειδωτικά βιοδραστικά. Συνολικά, τα αποτελέσματα της έρευνας σκιαγραφούν τα πολλά υποσχόμενα αντιοξειδωτικά οφέλη για την υγεία από τα γηγενή ελληνικά είδη γαρίδας της Θράκης, τα οποία εμφανίζουν αντάξιες συγκρίσεις με τα γνωστά εισαγόμενα είδη που είναι πλούσια σε βιοδραστικά λιπίδια.*

e-Poster

Bioactives of Water kefir microbiota extracts with antioxidant activity

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Kefir is an ancient, handmade, acidic beverage obtained by the fermentation of liquid culture media from kefir grains, using milk as the optimal medium, but also sugary water solutions, the production of which has now been industrialized and commercialized. Kefir grains consist of a symbiotic colony of microorganisms, including lactic acid-active bacteria, acetate bacteria, Bifidobacteria and several other bacteria like *Z .mobilis*, as well as fungi and yeasts. These microorganisms coexist in the granules and some can be transferred to the liquid phase. In addition, they are non-pathogenic and, in combination with the metabolites they produce, they induce a variety of health promoting effects [1].

The objective of the present study was to quantify the content of both amphiphilic bioactives (phenolics and polar lipids) and lipophilic bioactives (carotenoids) in extracts of a commercialized water kefir microbiota and assess their anti-oxidant capacity, in combination with structural quality analysis, in order to evaluate the potential antioxidant health promoting properties of water kefir microbiota and its bioactives against oxidative stress and associated manifestations.

The water kefir grains used were obtained from Ferment (Netherlands). Total lipids (TL) of water kefir samples were extracted and further separated into their total amphiphilic content (TAC) and total lipophilic content (TLC), as previously described [2], The total content in phenolics and carotenoids expressed in gallic acid equivalent (GAE) and β-carotene equivalent (CE) per gram of extract, in these extracts were determined as previously described, while their antioxidant activities to scavenge free radicals were evaluated by the ABTS (2,2′-azinobis-(3-ethylbenzothiazoline-6-sulfonic acid)) radical cation decolorization and the 2,2-diphenyl-1-picrylhydrazyl (DPPH) assays, expressed as μmol of Trolox equivalent (TE) / g extract and TE antioxidant capacity (TEAC), respectively, as previously described [2]. All spectrophotometric analyses were performed in a LLG-uni SPEC 2 spectrophotometer, while a Perkin Frontier ATR/FT-NIR/MIR spectrometer was used for structural analyses of the bioactives of these extracts in comparison to spectra obtained from standards of phenolics (gallic acid, catechin and quercetin), b-carotene and polar lipids, as previously described [3]

All extracts were rich in both carotenoids and phenolics, which explain the observed antioxidant capacity, as assessed by the ABTS assay. Nevertheless only TAC extracts showed potent TEAC antioxidant properties based on both the DPPH and ABTS assays, which seem to be consistent with the higher phenolic content found in these extracts of water kefir microbiota, in comparison to their TLC extracts which showed none bioactivity in this assay as well as in phenolic content evaluation too. Thus, the more bioactive compounds are mostly present in the TAC extracts of water kefir. These results seem to be related to the different lipophilicity of the TAC and TLC extracts, as the more lipophilic phenolic bioactives of TAC seem to more efficiently neutralize free radicals then the lipophilic carotenoids. High ABTS and TEAC values highlight the free radical scavenging abilities of these antioxidant bioactives against oxidative stress and the associated inflammatory manifestations and related disorders.

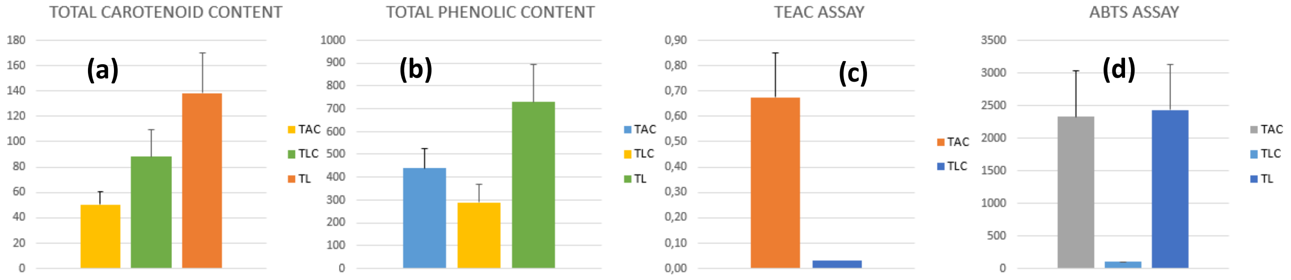

Figure 1. Total carotenoids (a) and phenolics (b) content and associated antioxidant capacity in ABTS (c) or TEAC values (d) of water kefir TAC, TLC and TL extracts

According to the obtained ATR-FTIR spectra of both extracts and standards several characteristic peaks were identified that can facilitate the structural analysis of the bioactives present in water kefir TAC extracts. The prominent peak at 3300 cm^{-1} (Peak 1) indicates the presence of hydroxyl (-OH) groups. Peaks in the range of 2900-3000 cm^{-1} (Peak 2) correspond to the stretching vibrations of simple C-H bonds, akin to those found in β-carotene and polar lipids. At around 1650 cm^{-1} (Peak 3), a peak appears indicative of C=C double bonds, which aligns with the characteristic peak of polar lipids. The region between 1300-1500 cm^{-1} shows three distinct peaks (Peak 4), likely associated with C-C bond phase vibrations and ring vibrations, confirming the existence of rings in the sample. In the fingerprint area, at approximately 1100 cm⁻¹ (Peak 5), the ether bond (C-O-C) is identified, which is also present in catechin and quercetin. The peak at about 950 cm⁻¹ (Peak 6) corresponds to hydrogen atoms associated with double bonds, similarly to β-carotene. Lastly, the peak observed at around 800 cm⁻¹ (Peak 7) is attributed to the C-H out-of-plane bending vibrations typical of aromatic rings, which is consistent with the known structures of catechin and quercetin. This comprehensive spectral analysis suggests the existence of unsaturated polar lipids, such as phospholipids or glycolipids, β-carotene and bioactive flavonoids.

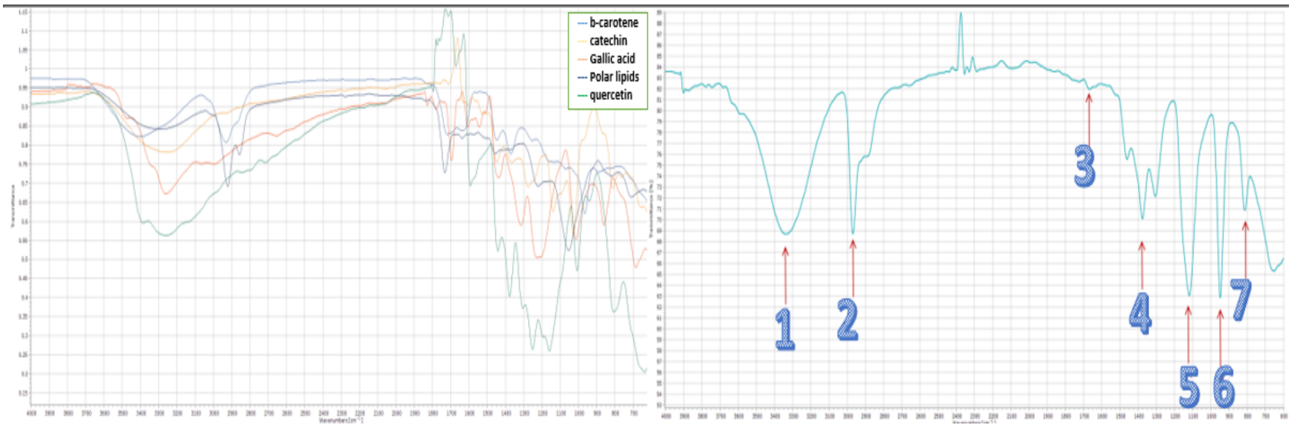

Figure 2.ATR-FTIR spectra (transmittance - wavenumbers) of standards (a) and water kefir TAC extracts (b)

Overall the outcomes of the present study showed that the most bioactive antioxidants of water kefir microbiota are predominantly its amphiphilic compounds, such as detected phenolic bioactives like the flavan-3-ol catechin and the flavonol quercetin flavonoids, which further support the antioxidant protection of water kefir based products and beverages against oxidative stress and associated disorders.

Aknowledgements: The authors would like to thank their supervisor, Assist. Prof. A. Tsoupras, as well as Ass. Prf. N. Vordos, Dr. A. Ofrydopoulou and Ms D. Papadopoulou for their continuous support

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Βιοδραστικά συστατικά εκχυλισμάτων της μικροχλωρίδας κεφίρ με αντιοξειδωτική δράση

Το κεφίρ περιέχει μια συμβιωτική αποικία βακτηρίων και μυκήτων και χρησιμοποιείται για την παραγωγή πολλών προϊόντων ζύμωσης. Σκοπός της παρούσης μελέτης ήταν η αναζήτηση στο κεφίρ νερού βιοδραστικών συστατικών αμφίφυλης και λιπόφυλης φύσης με αντιοξειδωτικές ιδιότητες. Για το σκοπό αυτό, αναπτύχθηκε μεθοδολογία που περιλάμβανε εκχύλιση των συστατικών λιποειδικής φύσης από κόκκους κεφίρ νερού, η ποσοτική εκτίμηση των επιπέδων φαινολικών και καροτενοειδών βιοδραστικών σε αυτά τα εκχυλίσματα του κεφίρ, καθώς και η εκτίμηση της αντιοξειδωτικής τους δράσης με την χρήση προτύπων βιοδοκιμασιών, ενώ με την χρήση ATR-FTIR φασμάτων τόσο των εν λόγω βιοδραστικών όσο και σχετικών προτύπων επιτεύχθει μια δομική σσυχέτιση δομής και δράσης των μορίων αυτών. Παρατηρήθηκε ότι πιο ισχυρή αντιοξειδωτική δράση ανιχνεύτηκε στα εκχυλίσματα των αμφίφυλων συστατικών του κεφίρ που συνάδει με το πλούσιο περιεχόμενο τους σε φαινολικά αντιοξειδωτικά, όπως τα βιοφλαβονοειδή κερκετίνη και κατεχίνη, αλλά και σε καροτενοειδη βιοδραστικά. Τα υποσχόμενα αυτά αποτελέσματα ενισχύουν την περεταίρω μελέτη για την χρήση των μικροοργανισμών του κεφίρ και των προϊόντων ζύμωσης του και των μεταβολιτών τους για την παραγωγή νέων βιολειτουργικών προϊόντων (τροφίμων, συμπληρωμάτων, προβιοτικών, κοσμητικών και φαρμακευτικών προϊόντων) πλούσιων σε αντιοξειδωτικά βιοδραστικά που προάγουν την υγεία .

ANTIOXIDANT BIOACTIVES OF THE FRESHWATER AQUATIC PLANT, *LEMNA MINOR*

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Natural sources rich in bioactives with less toxic side effects, such as those derived from pharmaceutical plants, have gained attention against oxidative stress related chronic diseases. This article discusses the potential of *Lemna spp.*, a neglected freshwater aquatic plant that typically grows naturally in wastewater treatment facilities, as a sustainable source of bioactives, particularly amphiphilic phenolics and lipids with antioxidant potency [1]. The objective of this study was to evaluate the self-grown in wastewater treatment facilities *Lemna minor* plant as a sustainable source of amphiphilic and lipophilic antioxidant bioactives, by evaluating its content in bioactive carotenoids and phenolics and their antioxidant activities in scavenging reactive oxidant species, along with structural elucidation based on Attenuated Total Reflection (ATR)-FTIR spectra analysis.

Samples of *Lemna minor* were obtained from the Fisheries Research Institute (FRI) and the wastewater facilities placed in Nea Peramos of Kavala, Greece. All UV-VIS spectrophotometric analyses were performed in a LLG-uniSPEC 2 spectrophotometer, evaporation in a Rotavapor R-300 Flash Rotary Evaporator and the ATR-FTIR analyses at the Perkin Elmer Frontier ATR/FT-NIR/MIR spectrometer. All reagents [Tris, HCl, Acetic acid, potassium persulfate, sodium carbonate, folin ciocalteu, 2,2-diphenyl-1-picrylhydrazyl (DPPH) and 2,2′-azinobis-(3-ethylbenzothiazoline-6-sulfonic acid) (ABTS)], solvents (octane, isopropanol, petroleum ether, methanol, ethanol, chloroform) and standards (trolox, galic acid, catechin, quercetin, soy polar lipids, β-carotene) were purchased from Sigma Aldrich (St Louis, Missouri, US). Extractions of total lipids (TL) and further separation into the total amphiphilic compounds (TAC) and total lipophilic compounds (TLC) were performed according to A. Tsoupras *et al.* [2]. The total phenolic and total carotenoid contents for each extract were measured as previously described .[2], using galic acid and b-carotene as standards. Total phenolic and carotenoid contents were expressed in mg of Galic Acid Equivalent (GAE) and β-carotene equivalent (CE) per gram of extract, respectively. The antioxidant activities of all samples were evaluated by applying the two different and distinct DPPH or ABTS based bioassays, using Trolox as a standard, as previously described [2], while the results were expressed as Trolox Equivalent (TE) Antioxidant Capacity (TEAC) and ABTS values (μmol of TE/g extract), respectively. ATR-FTIR based structural analysis of all samples was conducted according to N. Vordos *et al.*[3], using standards of different classes of bioactive phenolics (gallic acid, quercetin and catechin), soy polar lipids and β-carotene.

The TAC extracts of *Lemna minor* showed a higher total phenolic content than that of the TLC extracts, whereas carotenoids were identified in both extracts at comparable levels (Figures 1 and 2). The outcomes of the DPPH-based bioassay revealed that TAC extracts possess strong antioxidant activities, whereas TLC extracts did not show any such bioactivity at all. In contrast to DPPH, the results obtained by the ABTS-based bioassay revealed that both TAC and TLC extracts of *Lemna minor* possess antioxidant capacity, with the more amphiphilic TAC extracts being again the most bioactive antioxidant ones (Figures 3 and 4). Structural elucidation of the most bioactive TAC extracts, based on the obtained ATR-FTIR spectra, showed that different kind of bioactive phenolics were present in these extracts, since hydrosylable tannins like Gallic acid and highly bioactive flavonoids like the flavan-3-ol Catechin and the flavanol quercetin, as well as bioactive polar lipids and carotenoids, were identified according to characteristic fingerprint peaks when compared to spectra of the assessed standards (Figure 5). Overall, this aquatic plant contain bioactive carotenoids and phenolics with potent antioxidant potency, which can be incorporated as ingredients in functional products with health promoting properties against oxidative stress and associated disorders. These promising outcomes urge further study for this aquatic plant, in order to fully elucidate their potential as alternative sources of such antioxidant bioactives.

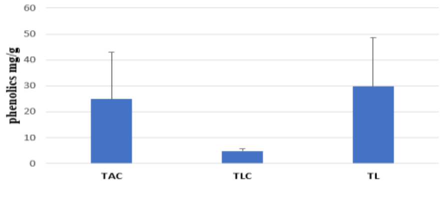

Figure 1. Total phenolic content of TAC and TLC extracts

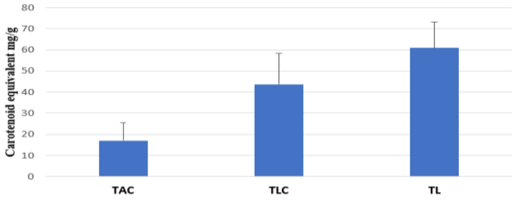

Figure 2. Total carotenoid content of TAC and TLC

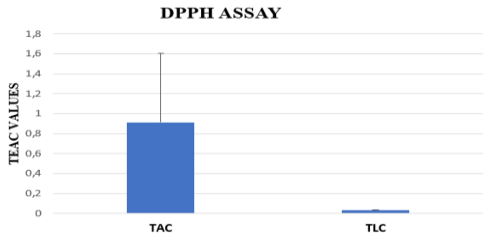

Figure 3. Antioxidant capacity (TEAC values) of TAC extracts

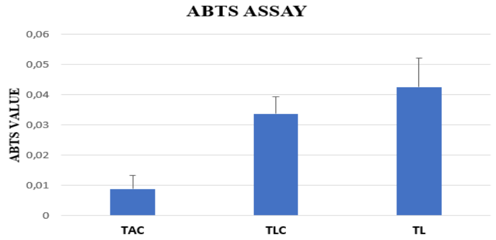

Figure 4. Antioxidant capacity (ABTS value) of TAC and TLC

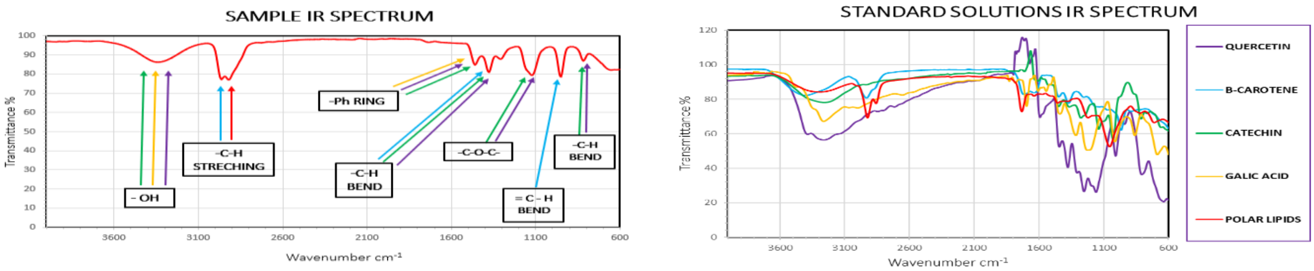

Figure 5. ATR-FTIR Spectrums of TAC extracts of *Lemna minor* samples (PTACI2) and solvent Isopropanol (A) and those of standards of Quercetin, β-Carotene, Catechin, Galic acid and Soy Polar lipids (B)

Acknowledgements: The authors would like to thank their supervisor (PI) Assist. Prof. A. Tsoupras, as well as Ass. Prof. N. Vordos, Dr. A. Ofridopoulou, Ms M. Seferli and FRI for their continuous support.

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ΒΙΟΔΡΑΣΤΙΚΕΣ ΟΥΣΙΕΣ ΑΠΟ ΤΟ ΦΥΤΟ LEMNA ΜΕ ΑΝΤΙΟΞΕΙΔΩΤΙΚΉ ΔΡΑΣΗ

Το αυτοφυές υδρόβιο φυτό Lemna spp., *το οποίο συνήθως αναπτύσσεται σε εγκαταστάσεις βιολογικού καθαρισμού, εξετάζεται σε αυτή τη μελέτη ως μια πιθανή αειφόρα παροχή βιοενεργών ουσιών, ιδίως αμφίφυλων και λιποειδών συστατικών με αντιοξειδωτικές ιδιότητες. Προκειμένου να εντοπιστούν πιθανές βιοδραστικές ουσίες όπως τα καροτενοειδή και τα φαινολικά και να αξιολογηθεί περαιτέρω η αντιοξειδωτική δράση αυτών με σάρωση ενεργών ειδών οξυγόνου, η μελέτη επιδίωξε τη διάκριση μεταξύ λιπόφιλων και αμφίφιλων συστατικών. Τα αποτελέσματα που προέκυψαν από συγκριτικές μελέτες στα εκχυλίσματα του φυτού παρουσίασαν παρόμοιες υψηλές τιμές στα καροτενοειδή, ενώ στα φαινολικά βρέθηκαν υψηλές μόνο στα αμφίφιλα εκχυλίσματα. Η αντιοξειδωτική δράση μετρήθηκε με τις μεθόδους DPPH και ABTS. Τα αμφίφιλα συστατικά παρουσίασαν αντιοξειδωτική δράση και στις δύο μεθόδους ενώ τα πιο λιπόφιλα εμφάνισαν αποτελέσματα μόνο με την μέθοδο ABTS.*

Ολοκληρώνοντας το εκχύλισμα παρουσίασε βιοδραστικότητα και επομένως θα μπορούσε να χρησιμοποιηθεί για λειτουργικά τρόφιμα και καλλυντικά.

EVALUATION OF ANTIOXIDANT PROPERTIES OF KIWI BY-PRODUCTS’ AMPHIPHILIC AND LIPOPHILIC BIOACTIVES

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Oxidative stress has a remarkable thesis in the occurrence of chronic diseases, and naturally derived antioxidants appear to have beneficial properties against these manifestations. Kiwi is a fruit that contains such beneficial antioxidants. The purpose of this paper is to evaluate kiwi by-products as a sustainable natural source of antioxidant bioactives while reducing environmental footprint and waste management cost, in a circular economy design, along with potential valorization of natural bioactives from this low value by-products as ingredients for high value functional products (nutraceuticals, cosmetics and pharmaceuticals) with health promoting properties [1] .

Samples of kiwi (*Actinidia deliciosa*) were of native Macedonian-Greek organic cultures,. Solvents (methanol, isopropanol, ethanol, n-octane , petroleum ether, chloroform), reagents (Tris-HCL ,Na_2CO_3, DPPH, ABTS, sodium persulfate, acidic acid, acidic sodium acetate) standards of phenolics (gallic acid, catechin, quercetin), soy polar lipids:β-carotene and trolox were purchased from Sigma Aldrich (St. Louis, Missouri, US). For all spectrophotometric analysis the UV-VIS vis spectrophotometer was used while the Attenuated total reflectance (ATR) - Fourier Transform Infrared Spectroscopy (FTIR) spectrometric structural analyses, of both samples and standards, were performed in a Perkin Elmer Frontier ATR/FT–NIR/MIR spectrometer.

The extraction of total lipid compounds (TL) of kiwi by-products and their separation into total amphiphilic content (TAC) and total lipophilic content (TLC), as well as the quantification of the total phenolic content (TPC), the total carotenoid content (TCC) and the antioxidant activity of all extracts, based on both the DPPH and ABTS bio-assays, where performed according to Tsoupras et al., 2024 [2]. ATR and FTIR spectrometric structural analyses were performed according to Vordos et al., 2018 [3].

TAC and TLC extracts of kiwi by-products showed similar antioxidant activity in DPPH, ABTS and TCC and TPC content (Figure 1). Thus, the antioxidant activity of all extracts of kiwi by-products can be attributed to both their lipophilic (TCC) and amphiphilic (TPC) bioactive molecules. ATR-FTIR spectra of the TAC. Overall, kiwi by-products contain both phenolic and carotenoid antioxidant bioactives that are potential candidates as natural antioxidant ingredients for developing health promoting functional products.

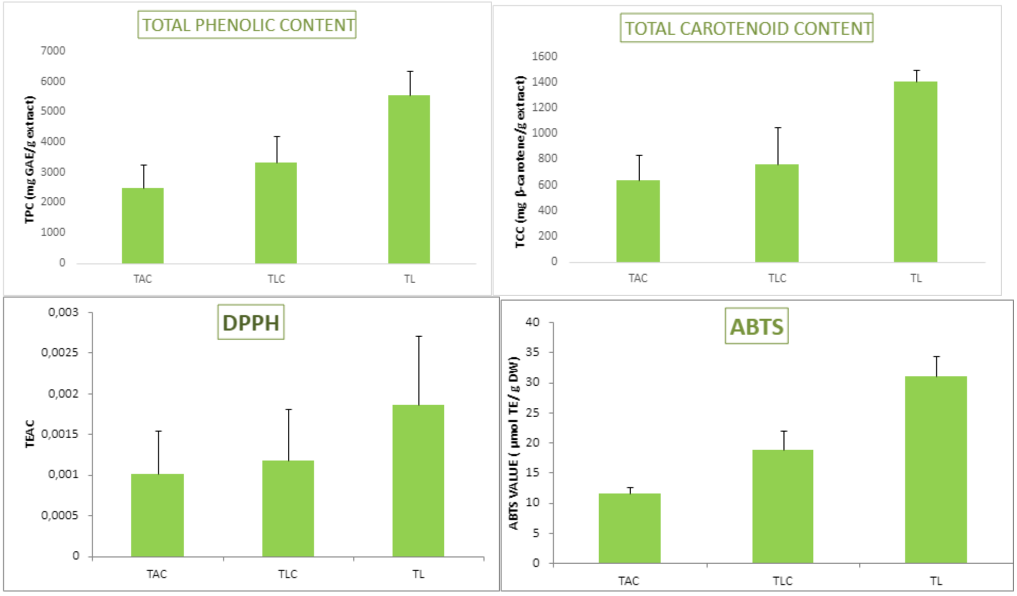
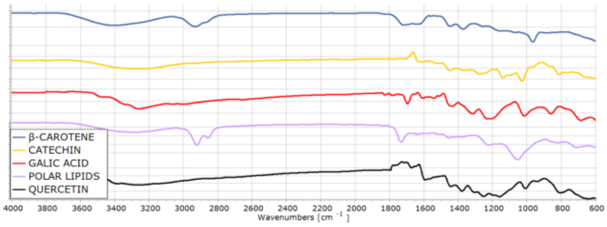


Figure 1. TPC (A), TCC (B) and Antioxidant Activity based on the DPPH assay (C) and the ABTS assay (D)



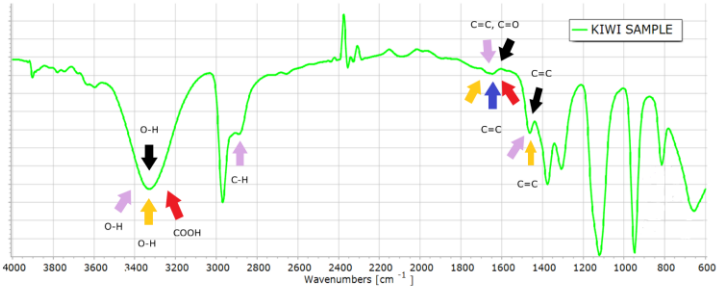


Figure 2:FTIR spectra of bioactive compounds found in kiwi.

Figure 3: FTIR spectra of kiwi sample.

Table 1. Characteristic ATR-FTIR Fingerprint Peaks of samples compared to those of samples

Compounds	β-carotene	Catechin	Gallic acid	Polar lipids	Quercetin
Peak (cm^{-1})	1644	3600-3100	3400-2800	3550-3100	3600-3050
Functional groups	C=C alkene	O-H alcohol	COOH carboxyl acid	O-H alcohol	O-H alcohol
Peak (cm^{-1})		1630-1600	1610	2860	1670
Functional groups		C=C aromatic, C=C alkene	C=C aromatic	C-H alkane	C=C alkene, C=O ketone
Peak (cm^{-1})		1450		1635	1450
Functional groups		C=C aromatic		C=C alkene, C=O ketone	C=C aromatic
Peak (cm^{-1})		814(Fingerprint region)		1455	950, 814,640 (Fingerprint region)
Functional groups				C=C aromatic	
Peak (cm^{-1})				822(Fingerprint region)	

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ΕΚΤΙΜΗΣΗ ΤΩΝ ΑΝΤΙΟΞΕΙΔΟΤΙΚΩΝ ΙΔΙΟΤΗΤΩΝ ΤΩΝ ΑΜΦΙΦΙΛΩΝ ΚΑΙ ΛΙΠΟΦΙΛΩΝ ΒΙΟΔΡΑΣΤΙΚΩΝ ΑΠΟ ΠΑΡΑΠΡΟΪΟΝΤΑ ΑΚΤΙΝΙΔΙΟΥ

Ο σκοπός της παρούσας εργασίας είναι η αξιολόγηση των παραπροϊόντων του ακτινιδίου ως βιώσιμη φυσική πηγή βιοδραστικών αντιοξειδωτικών ουσιών με ταυτόχρονη μείωση του περιβαλλοντικού αποτυπώματος και του κόστους διαχείρισης απορριμμάτων. Πραγματοποιήθηκε προσδιορισμός της ποσότητας των φαινολικών (TPC), των καροτενοειδών (TCC) και της αντιοξειδωτικής δράσης τους με βάση προτύπων μεθόδων (DPPH και ABTS) και ποιοτική δομική ανάλυση με ART-FTIR. Τα εκχυλίσματα των λιπόφιλων και των αμφίφιλων βιοδραστικών των παραπροϊόντων ακτινιδίου επέδειξαν παρόμοια αντιοξειδωτική δράση των δειγμάτων, που συνάδει με την παρόμοια σύσταση τους σε αμφίφυλα φαινολικά και πιο λιπόφιλα καροτενοιειδή βιοδραστικά. Τέλος με την ταυτοποίηση χαρακτηριστικών κορυφών στα φάσματα FTIR των δειγμάτων σε σύγκριση με φάσματα προτύπων φαινολικών και λιποειδών επιβεβαιώνεται η παρουσία τέτοιων αντιοξειδωτικών βιοσυστατικών στα εκχυλίσματα παραπροϊόντων ακτινιδίου. Τα αποτελέσματα αυτά ενισχύουν την προτεινόμενη αξιοποίηση παραπροϊόντων ακτινιδίου για εκχυλίσματα πλούσια σε αμφίφιλα και πιο λιπόφυλα αντιοξειδωτικά ως συστατικά για λειτουργικά προϊόντα υψηλής αξίας (τρόφιμα, καλλυντικά και φαρμακευτικά προϊόντα) που προάγουν την υγεία, στα πλαίσια της κυκλικής οικονομίας

e-Poster

SYNTHESIS AND CHARACTERIZATION OF GRAPHENE-BASED SORBENT MATERIALS

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In the present work, an attempt is made to remove diclofenac from aqueous solutions using graphene oxide composites as adsorbents. Diclofenac (DCF) is a non-steroidal anti-inflammatory drug (NSAID), which has been detected at the water surface and appears to threaten aquatic ecosystems. Therefore, the removal of this contaminant using a novel GO@ZnO-chitosan-lignin material is an interesting approach with applications in municipal wastewater treatment [1].

Graphene oxide (GO) is a special material, which could be considered as a single unimolecular layer of graphite with numerous oxygen-containing functional groups, for example epoxide, carbonyl and hydroxyl groups. GO finds application in nanocomposites, synthetic polymers, energy storage, physical processes such as catalysis and adsorption [2]. Zinc oxide (ZnO) is a crystalline semiconducting material exhibiting diverse outstanding physical and chemical properties such as piezoelectricity, optical transparency and biocompatibility. ZnO nanocrystals, enhance the photocatalytic performance since they organize the morphology, size and orientation of the crystallites [3] [4]. Chitosan (Cs) is a biopolymer whose molecular structure contains $-NH_2$ and -OH groups. The presence of these increases its adsorption applications with other adsorbent molecules. Its main advantage is the decontamination of wastewater from organic or inorganic pollutants. Furthermore, it exhibits good adsorption performance due to its high stability and simple polymerization process and combines low cost [5] [6]. Similarly, the amorphous, phenolic polymer of lignin (Lgn) is a complex material, which is distinguished by its ability to adsorb organic and inorganic pollutants from water. This is due to the abundance of the material, its physicochemical properties, low cost and the presence of active centers [7].

The GO synthesis was performed by the modified Hummers method. Two composites were produced: chitosan-lignin and chitosan-lignin-GO-ZnO. For the synthesis of CS-Lgn, a 1:1 ratio with 2% acetic acid solution was used and ultrasonic processing was performed with the addition of each material. Finally, after the addition of acetic acid, the solution was stirred for 4 hours and afterwards glutaraldehyde was added. The CS-Lgn-GO@ZnO was synthesized in a similar way and the final products were freeze-dried. The experimental part continues by evaluating their adsorption efficiency at different pH values (3-11) and contact times (5-90 minutes).

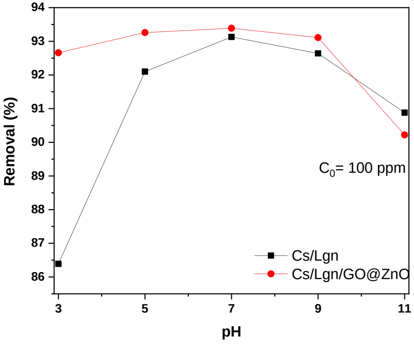

Figure 1: Effect of pH

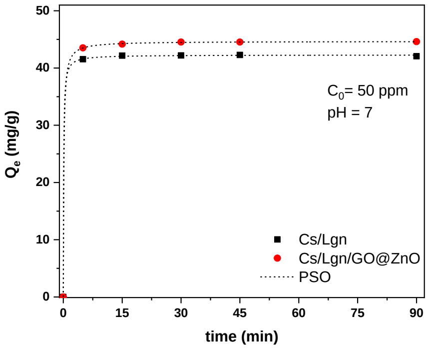

Figure 2: Effect of contact time

According to Figure 1, maximum removal of the pollutant was observed at pH=7, where the removal rate exceeds 92.5%. Subsequently, at this pH value, the removal time of the pollutant was studied, where it is shown in Figure 2. More specifically, the kinetics of the adsorbent is quite fast, as equilibrium is reached within 15 minutes. A better adsorption model, seems to be the pseudo-second model, as both the fitting and the R^2 coefficient, take higher values, compared to the pseudo-first model, as indicated in Table 1. This fact, suggests that chemisorption takes place, therefore the adsorption rate depends on the adsorption capacity of the material and not on the concentration of the adsorbed substance.

The existence of lignin in the material is confirmed by the strong aromatic vibrations at 1605, 1516 and 1425 cm^{-1}. The broad band at 3500-3200 cm^{-1} is attributed to aromatic and aliphatic -OH groups. The presence of N-acetyl groups becomes visible at 1600 cm^{-1} (C=O amide group voltage vibration). Also, chitosan gives the vibrations at around 1650 and 1560 cm^{-1}, which are related to the carbonyl bonds of amide II and the vibrations of amide I, respectively. XRD analysis shows the characteristic peaks of each material. The addition of GO@ZnO is confirmed by the peak at ~10◦ which corresponds to GO.

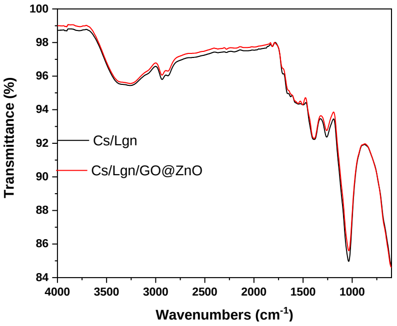

Figure 3: FTIR spectra

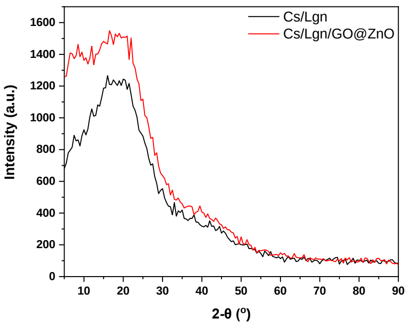

Figure 4: XRD diagram

ΣΥΝΘΕΣΗ ΚΑΙ ΧΑΡΑΚΤΗΡΙΣΜΟΣ ΡΟΦΗΤΙΚΩΝ ΥΛΙΚΩΝ ΜΕ ΒΑΣΗ ΤΟ ΓΡΑΦΕΝΙΟ

Το οξείδιο του γραφενίου, αποτελεί ένα ξεχωριστό υλικό, λόγω των ιδιοτήτων που εμφανίζει, το οποίο χρησιμοποιείται συχνά σε φυσικές διεργασίες, όπως αυτή της προσρόφησης. Η ανάμειξη του GO με υλικά όπως το οξείδιο του ψευδαργύρου, η χιτοζάνη και η λιγνίνη, δημιουργούν ένα σύνθετο υλικό, το οποίο συνδυάζει τις ιδιότητες και των τεσσάρων υλικών, με αποτέλεσμα να προκύπτει ένα αρκετά καλό υποψήφιο προσροφητικό μέσο ρύπων αστικών λυμάτων, όπως είναι η φαρμακευτική ουσία δικλοφενάκη. Για τη σύνθεση του GO, ακολουθήθηκε η μέθοδος Hummers. Στη συνέχεια, σε υδατικά διαλύματα δικλοφενάκης, προστίθενται στερεό CS-Lgn και CS-Lgn-GO@ZnO. Ακολούθησαν πειράματα προσρόφησης, σε διάφορες τιμές του pH, και έπειτα εξετάσθηκε η επίδραση του χρόνου προσρόφησης, στη βέλτιστη τιμή pH. Από τα αποτελέσματα, προέκυψε ότι η βέλτιστη τιμή pH για την απομάκρυνση της DCF είναι το 7, και η ισορροπία κατά την πάροδο της απομάκρυνσης, επιτεύχθηκε στα 15 λεπτά. Καταλήγοντας, το μοντέλο που εκφράζει πιο ορθά τα παραπάνω αποτελέσματα αυτό της ψευδο-δεύτερης τάξης, επομένως γίνεται λόγος για χημειορόφηση.

The authors would like to thank Professor G. Kyzas for the supervision and c. PhD. K. Maroulas and Dr. P. Efthymiopoulos for their assistance.

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ANALYSIS OF IONIC LIQUIDS: A MOLECULAR DYNAMICS STUDY

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Ionic liquids (ILs) are a new class of solvents fully composed of ions and existing in a liquid state at or near room temperature. These liquids, which are typically below 100°C, consist of an organic cation and either an organic or inorganic anion [1][2]. The combination of different anions and cations in ILs creates an infinitely large number of compounds with varied physical and chemical properties, allowing for the judicious selection of the optimal IL for specific chemical reactions [1]. ILs have garnered significant interest among researchers in physics and chemistry due to their unique properties compared to conventional molecular liquids, such as negligible vapor pressure and thermal and chemical stability [2]. These properties make ILs suitable for environmentally benign industrial processes, serving as alternatives to toxic, volatile organic compounds [1]. Moreover, ILs have been used as solvents to perform organic reactions with high yields [2]. The intriguing characteristics of ILs can largely be attributed to specific interionic interactions, which are crucial for understanding their behavior at the molecular level [2]. Both experimental and theoretical studies have focused on how these interionic interactions, a type of intermolecular interaction, influence the physical and chemical properties of ILs within the realm of condensed-phase research [2].

Molecular dynamics (MD) simulation is a technique used to calculate the equilibrium and transport properties of a classical many-body system. "Classical" refers to the nuclear motion of the constituent particles adhering to classical mechanics, which effectively approximates the translational and rotational motion of a wide range of molecules [3]. It has been demonstrated that using classical atomistic-level simulations to estimate the physical parameters of ionic liquids is an effective method. Pure liquid characteristics including density (liquid and crystalline), structure, heat capacity, enthalpy of vaporization, compressibility and volumetric expansivity, self-diffusivity, and viscosity have all been calculated using molecular dynamics simulations [4].

We decided to study particularly with the imidazolium-based ionic liquid 1-ethyl-3-ethylimidazolium ethylsulfate as it is an important ionic liquid due to its unique combination of low toxicity, biodegradability, and excellent solvation properties, making it highly suitable for green chemistry and sustainable industrial applications.

The methodology for creating a simulation model using molecular dynamics simulation was as follows: First, thorough research was conducted in order to find the proper and most accurate force field parameters of our ionic liquid, by studying various articles. Then, Avogadro was used for the visualization of both molecules ([EEIM] and [ESO4]) and for the calculation of some parameters. Once all the force field parameters were established, an input file was created with all of the force field parameters. Finally, LAMMPS software was utilized for the modeling simulation.

Simulation Details; Force field:

A conventional classical force field is employed, which includes bond stretching, angle bending, dihedral or torsion angle rotation, and improper angle bending. Additionally, it models both intramolecular and intermolecular van der Waals and Coulombic interactions. The functional form is as follows [4]:

$$U_{\text{total}} = U_{\text{bond}} + U_{\text{angle}} + U_{\text{torsion}} + U_{\text{improper}} + U_{\text{vdw}} + U_{\text{qq}} \quad (1)$$

$$\begin{aligned} U_{\text{total}} = {} & \sum_{\text{bonds}} k_b (r - r_0)^2 + \sum_{\text{angles}} k_\theta (\theta - \theta_0)^2 + \\ & \sum_{\text{dihedrals}} \sum_{n} k_\phi [1 + \cos(n\phi - \delta)] + \sum_{\text{impropers}} k_\psi (\psi - \psi_0)^2 + \\ & \sum_{i=1}^{N-1} \sum_{j>1}^{N} \left\{ 4\epsilon_{ij} \left[\left(\frac{\sigma_{ij}}{r_{ij}} \right)^{12} - \left(\frac{\sigma_{ij}}{r_{ij}} \right)^{6} \right] + \frac{q_i q_j}{4\epsilon_0 r_{ij}} \right\} (2) \end{aligned}$$

Simulation Methods:

A variety of simulation methods, algorithms, and programs were employed to compute the wide range of properties in this study. The simulations utilized a timestep of 1 femtosecond, with systems equilibrated for 50,000 timesteps in the NVT ensemble, followed by equilibration for 200,000 timesteps in the NPT ensemble, and finally 500,000 timesteps in the NPT ensemble for statistical calculations of means. Cell volume was 9299.66 Å^2 and the results were obtained at 298.031 K.

While the temperature is 298.03 K, the given density is 1.20337 g/cm³ [6], while the experimental density measures 1.43054 g/cm³, underscoring a noteworthy disparity requiring examination and interpretation.

Given the complex nature of the rest calculations, they may contain errors or require reconsideration, necessitating careful review and validation:

Potential energy	U	-5.2345 kcal/mol
Pair energy	E_{pair}	-41.2079 kcal/mol
molecular energy	E	35.9734 kcal/mol
total energy	E_{total}	1.8585 kcal/mol
Van der Waals energy	E_{vdW}	1.2788 kcal/mol
Coulomb energy	E_C	7.4245kcal/mol
Bond energy	D / E_b	24.9464 kcal/mol
Angle energy	E_θ	11.027 kcal/mol
Dihedral Angle energy	E_ϕ	0 kcal/mol
Long Range energy	E_{lr}	-49.9198 kcal/mol
Enthalpy	H	1.8510 kcal/mol

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ΑΝΆΛΥΣΗ ΙΟΝΤΙΚΏΝ ΥΓΡΏΝ: ΜΕΛΈΤΗ ΜΟΡΙΑΚΉΣ ΔΥΝΑΜΙΚΉΣ

Τα ιονικά υγρά είναι μια κατηγορία διαλυτών που αποτελούνται από ιόντα, έχουν μοναδικές ιδιότητες καθιστώντας τα κατάλληλα για φιλικές προς το περιβάλλον βιομηχανικές διεργασίες. Η ανάπτυξη των δυναμικών πεδίων και των εξελιγμένων μεθόδων μοντελοποίησης, σε συνδυασμό με την αύξηση της υπολογιστικής ισχύος, κατέστησαν τις ατομικές προσομοιώσεις μοριακής δυναμικής (MD) των ιοντικών υγρών απαραίτητες για την κατανόηση των σχέσεων δομής-ιδιοτήτων σε μοριακή κλίμακα. Στην παρούσα εργασία χρησιμοποιείται ένα ενιαίο κλασικό πεδίο δυνάμεων για τον υπολογισμό ενός φάσματος θερμοδυναμικών ιδιοτήτων για το ιοντικό υγρό [EElm]-[EtSO4].

e-Poster

CREATION OF AN EDUCATIONAL SCENARIO FOR THE PURPOSE OF TEACHING THE SUBJECT OF pH

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The motive behind the creation of this assignment was the fact that students face difficulties understanding in depth the various terms in chemistry, resulting in a poorer performance when it comes to achieving a satisfactory grade in the PanHellenic (university entrance) exams. The objective of this assignment is, on the one hand, the enumeration of the teaching suggestions already applied and, on the other hand, the presentation of new educational scenarios that will bring about a simplified explanation of the subject matter and the best results regarding its acquisition.

The main causes are the lack of understanding of the subject matter as well as the insufficient motivation and encouragement by teachers, in order to deconstruct the belief that chemistry as a subject – and specifically teaching about pH – is full of difficulties. In most classrooms, chemistry is taught in the form of lectures. The teachers usually exclusively use the school textbook and dictate information to the students without any further explanations. The school textbook structures the lesson plan, provides the basic theory, trains and evaluates the student. In other words, it possibly occupies the most important place in the teaching process. Its content is considered to be incontrovertible, it is provided by the state free of charge and it is simultaneously used by all school units nationwide [1]. Finally yet importantly, it is taught in a regular classroom where practical application in a laboratory is completely absent. All of the above undermine the value of chemistry as a science making it less interesting and worth-pursuing to students, who do not get acquainted with the laboratory background of the subject, which comprises its greatest part. When teaching about pH specifically, the teachers settle on simply reading the theory as presented in the school textbook and doing some basic exercises. The detailed explanation of hard-to-understand terms, like the definition of pH and various phrases regarding acids and bases, is usually disregarded, while emphasis is given on learning the theory by heart and doing exercises. The main exercises students are asked to solve are about titration, which is a relatively complex procedure when only explained in theory.

Finding a proper way of teaching in relation to the acquisition of new knowledge is the object of debate among many researchers and it is especially interesting in terms of research. This teaching scenario is comprised of a series of coordinated activities aiming at one or more subjects, using both everyday and innovative ICT tools. It consists of the total of all the school textbooks, worksheets, software, learning theories and teaching practices. It is all the educational practices daily conducted in classrooms and the roles played by students and teachers alike in order to achieve a specific educational goal. This educational scenario is something applicable and not more complex than what is already happening in the classroom. Simply put, some basic interventions regarding the organization and planning of the lesson and the evaluation of the results of these changes are suggested. The educational scenarios suggested and analyzed in this assignment (figure 1) are the application of new technologies in education, laboratory experiments, changes in educational exercises outside the school environment, the introduction of projects in education, thematic educational visits, teaching by scientists of a relevant field and finally it would be a serious omission not to mention the DESTE educational model [2]. The presentation of an experimental procedure in person or via audiovisual media has the potential to benefit students in comprehending and quickly doing exercises, the same as in other educational scenarios.

Student participation and doing exercises on the board, which can be made more appealing and urge children to study more meticulously and thoroughly, are equally important. Besides that, this kind of activities improves their memory and performance speed. Despite the fact that schoolbooks are updated and sufficiently clear in meaning, teachers should enrich the teaching materials with articles, extracurricular exercises or video projections. Actually, using interactive tools and software applications, conducting games and activities focusing on pH, like interactive experimental simulations or Q&A games, becomes possible.

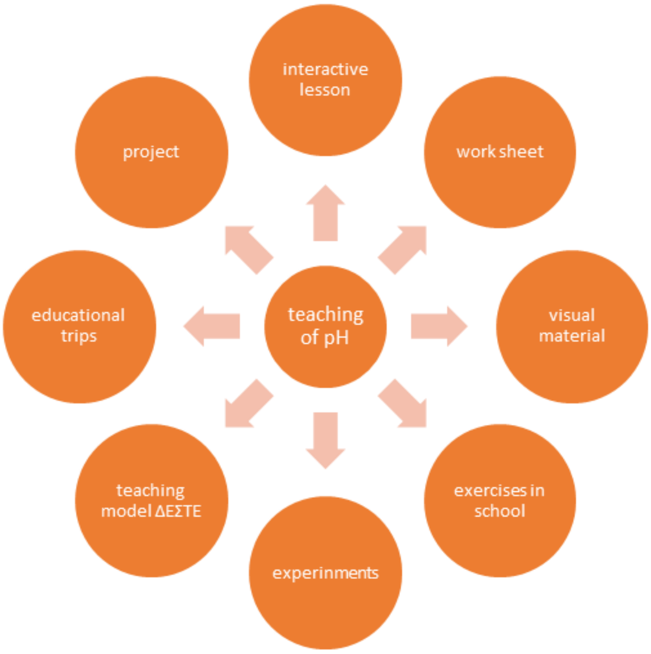

Figure 1: Proposals to reinforce the teaching of pH

Finally, alternative suggestions that could be employed in order to turn teaching chemistry and teaching about pH specifically into a more pleasant, appealing and comprehensible process for students, are presented. All of the above are the writers’ suggestions aiming at differentiating and improving teaching about pH. In conclusion, it can be effortlessly inferred that the application of the aforementioned teaching scenarios can result in the best possible comprehension of the unit with the aid of a more amusing and student-friendly method. If the teaching method changes in even one of the categories mentioned above, it is believed that the future generations will have the ability and the appropriate materials to master the required new knowledge in order to evolve in the area of exact science.

Acknowledgments: The authors would like to thank Dr. A. Thysiadou for her supervision.

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ΔΗΜΙΟΥΡΓΙΑ ΔΙΔΑΚΤΙΚΟΥ ΣΕΝΑΡΙΟΥ ΓΙΑ ΤΗ ΔΙΔΑΣΚΑΛΙΑ ΤΗΣ ΘΕΜΑΤΙΚΗΣ ΕΝΟΤΗΤΑΣ pH

Η πρόκληση που παρουσιάστηκε στην εργασία αυτή ήταν η διερεύνηση των ήδη εφαρμοσμένων προτάσεων διδασκαλίας και η παρουσίαση νέων διδακτικών σεναρίων για τη θεματική ενότητα του pH. Κύριο πλεονέκτημά αποτελεί η πρακτική εφαρμογή στην εκάστοτε σχολική εγκατάσταση και παράλληλα η συνεισφορά στη νέα γνώση η οποία θα επιφέρει διττά αποτελέσματα τόσο ως προς τους βαθμούς που θα οδηγήσουν στην εισαγωγή σε μια τριτοβάθμια σχολή της επιλογής του υποψηφίου όσο και ως προς την ενίσχυση του ενδιαφέροντος αναφορικά με αυτή τη μοναδική επιστήμη που φέρει το όνομα χημεία. Μέσα από αυτές τις δράσεις θα μπορέσει η παρεξηγημένη, δύσκολη και δυσνόητη χημεία να μετουσιωθεί σε μια ενδιαφέρουσα και πανίσχυρη επιστήμη.

HOLISTIC DIDACTIC APPROACH, FOR TEACHING THE THEMATIC UNIT OF “ACIDS-BASES-SALTS”

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This study aimed to investigate the teaching method applied to the subject of chemistry in secondary education and more specifically to the area of acids, bases, and salts. Traditional pedagogical strategies hold the primary position however their effectiveness in promoting the understanding of new knowledge is increasingly challenged. Therefore, the main objective of the authors was to propose new and innovative teaching strategies that not only enhance understanding but also modify the educational process for both students and teachers.

The difficulties in understanding and consolidating the acids, bases, and salts modules are a multifactorial issue. First of all, the limited time available, combined with the textbooks used to teach this chapter, does not allow the students to understand and simultaneously consolidate the chemical terms. To begin with, the terms acids, bases, and salts would be wise to teach the terms first in order to be fully understood by the students and to avoid confusion with the term pH. Additionally, the textbook mostly presents the Arrhenius theory of acids, bases and salts, with no inclusion of the more recent Brønsted-Lowry and Lewis theories. These theories are only introduced in the senior year of high school, by which point students are considered to have grasped the broader concepts of acids, bases, and salts and are introduced to more difficult terms and methodologies such as ionization, volumetry, buffering solutions, and solubility. Teachers should also have a relevant subject area, given the fact that chemists have extensive training that focuses specifically on the principles, theories, and practical applications of chemistry. Their deep understanding of chemical reactions, bonds, structures, and the periodic table equips them with the necessary expertise to effectively convey complex concepts to students in a way that encourages understanding and critical thinking.

In this research, a fundamental reconfiguration of teaching and assessment methods are proposed. The integration of interactive and experiential learning methods is advocated, utilizing a variety of resources, experimental learning, and collaborative activities to explain the detailed principles that dominate in acids, bases, and salts, such as teaching through experiments, and workshops as a means of teaching, the use of videos during teaching, teaching through the project method and teaching with concept cartoons. The incorporation of experimentation into the teaching process promotes an active approach to learning. This makes the learning process more exciting and interesting, while at the same time increasing students' confidence in their own abilities. The teacher in collaboration with the school and with a university institution or an industrial facility has the possibility to organize excursions to organized laboratories, given the fact that laboratories and reagents are usually not available in the school units. This offers a very special opportunity for students to extend their knowledge beyond the confines of the classroom and to have a real educational experience. At the same time, this activity facilitates the link between theoretical knowledge and practical application, providing an exciting educational step for students, to discover the importance of chemistry for everyday life [1]. The project teaching method, as it is referred to, helps students as they investigate, share knowledge and experiences, and design the experiment in the specific case they are studying, thus enhancing the deepening of learning and the acquisition of skills. It is very much reminiscent of a combination of what Piaget refers to as the Constructivist Model of Teaching and what Bruner identifies as Discovery or Exploratory Learning. On the one hand, students construct new knowledge out of the existing one, as they connect their actions to previous ones through active participation in experiences and problems (experimentation), creating a learning continuum, while on the other hand, they are encouraged to discover knowledge through interactive tasks and experiments [2]. The use of video screenings of chemical experiments in the classroom is an essential part of the modern educational process, bringing revolutionary benefits for students and teachers alike. Video provides a realistic view of the process and results, allowing students to understand more easily the scientific phenomena presented because of the visual representation of the experiments [3]. The idea concept cartoon in education came from Stuart Naylor and Brenda Keogh in 1991, with the aim of being effective because they are based on everyday situations, making science less intimidating and more engaging for students. Conducting a chemistry lesson requires a course of instruction with the ultimate goal of not only acquiring new knowledge but also keeping the learner's interest undiminished [4]. The educator must, depending on the class, the age, and the particular characteristics of both the lesson and its audience, follow a tactic to enable the student to develop their skills, consolidate the knowledge given to them, and master 'learning'.

In addition, innovative assessment techniques such as true or false questions, matching, crossword puzzles, and other playful approaches designed to assess understanding while promoting critical thinking and problem-solving skills are provided (Figure 1). Apart from the evaluation examples, there is also the solution and more detailed exercises of right/wrong, matching, and crossword puzzles, in order to enable the use of this teaching material by each teacher.

Figure 1. Innovative evaluation technique

By embracing innovation and adapting new educational practices to meet the evolving needs of students, it is possible to unleash the full potential of every student and foster a generation of scientifically developed individuals capable of facing the challenges of the scientific world.

Acknowledgments: The authors would like to thank Dr. A. Thysiadou for her supervision.

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ΟΛΙΣΤΙΚΗ ΔΙΔΑΚΤΙΚΗ ΠΡΟΣΕΓΓΙΣΗ, ΓΙΑ ΤΗ ΔΙΔΑΣΚΑΛΙΑ ΤΗΣ ΘΕΜΑΤΙΚΗΣ ΕΝΟΤΗΤΑΣ «ΟΞΕΑ-ΒΑΣΕΙΣ-ΑΛΑΤΑ»

Η παρούσα εργασία εξετάζει τη διδασκαλία της χημεία στα ελληνικά σχολεία της δευτεροβάθμιας εκπαίδευσης, με έμφαση στη θεματική ενότητα οξέα, βάσεις και άλατα. Αναφέρονται οι παραδοσιακές μέθοδοι διδασκαλίας, αποκαλύπτοντας περιορισμούς και τομείς προς βελτίωση. Ακολουθώντας τα πρωτόκολλα του Υπουργείου Παιδείας, Θρησκευμάτων και Αθλητισμού, στόχος των συγγραφέων είναι να προταθούν καινοτόμες παιδαγωγικές προσεγγίσεις για την ενίσχυση της εμπλοκής των μαθητών και την εμβάθυνση της κατανόησης. Τα ευρήματα υπογραμμίζουν την εκτεταμένη χρήση συμβατικών μεθόδων διδασκαλίας που χαρακτηρίζονται από τη μάθηση και τον περιορισμένο πρακτικό πειραματισμό. Προτείνεται μια μετάβαση στη διδασκαλία βασισμένη στην έρευνα, που συμπληρώνεται από διαδραστικές επιδείξεις, εργαστηριακές ασκήσεις, πολυμέσα και ο εμπλουτισμός των μεθόδων διδασκαλίας με την παροχή ευκαιριών βιωματικής μάθησης μέσω επισκέψεων σε πανεπιστήμια και βιομηχανικά κέντρα, με στόχο την βαθύτερη κατανόηση της νέας γνώσης.

e-Poster

PURIFICATION OF REAL WASTEWATER FROM THE PLASTICS INDUSTRY BY THE ELECTROCOAGULATION METHOD

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This study considers the removal of different pollutants, such as microplastics, biocides and dyes, from real waste waters by electrocoagulation (EC) treatment. Metal electrodes and electrical current are used in electrocoagulation by releasing metal ions that interact with pollutants and aggregate to form flocs. EC can effectively remove oils, heavy metals, and organic matter.[1]

Electrodes composed of iron and aluminum are essential to the electrocoagulation process used for treating wastewaters. Iron electrodes release ferrous ions, forming effective coagulants, while aluminum electrodes release aluminum ions, yielding similar results. Iron is inexpensive, less susceptible to pH shifts, and appropriate for a variety of pollutants. But it creates additional sludge. Aluminum is less sludge-producing and effective, but it is sensitive to pH changes and needs to be monitored carefully. Despite this, aluminum is favored for its lower sludge production.[2]

The amount of oxygen required for the chemical oxidation of both organic and inorganic substances in water is measured by Chemical Oxygen Demand (COD). It's an essential indicator for evaluating the quality of water, especially for tracking organic pollutants. High COD levels signify increasing levels in organic matter, which can have an adverse effect on aquatic ecosystems. Seeing as COD tests yield results quickly and are used by environmental organizations to guarantee that legislation is adhered to. The unit of measurement is mg O_2/L H_2O. For a wastewater to be suitable for discharge to the phreatic zone it must have a value of less than 120 mg/L. [3]

The experiments were conducted using an electrochemical reactor equipped with a magnetic stirrer. A DC power supply was used to provide constant current and a multimeter to measure electric current. Also, a small amount of NaCl was added as an electrolyte to assist the electrochemical treatment with both Fe and Al electrodes. In both measurements the parameters were kept constant; the electric current intensity at 900 mA, the total time of treatment 3 hours and the sampling 10 ml which was taken with a pasteur pipette every hour. The sample obtained was filtered and then transferred to the refrigerator for storage. To keep the intensity of the electric current constant, the potential difference of the system varied. In addition, both in the initial waste and after each sampling, the temperature was measured with a thermometer. For the measurement of COD, the sample was added to a glass vial with a specified amount of $K_2Cr_2O_7$ (calculated on the basis of the measuring instrument) to oxidize the organic compounds it contained. Then the solution, put in a thermoreactor, for boiling where it stood for 2 hours at 148°C. Finally, the sample was transferred to a spectrophotometer where the COD value was measured in mg O_2/L H_2O. The results as well as the % yield (relative to the original waste) are shown in the tables below. $\% \, yield = \frac{COD_{(0\ time)} - COD_{(i\ time)}}{COD_{(0\ time)}}$

Table 1; Results with Fe electrodes

Time (h)	Temperature(°C)	Intensity (mA)	Voltage (V)	COD (mg O_2/L H_2O)	% Yield
0	19	900	3.5	18,100	0
1	21	900	3.5	11,300	37.57
2	26	900	3.5	8,200	54.70
3	26	900	6.5	7,100	60.77

Table 2; Results with Al electrodes

Time (h)	Temperature (°C)	Intensity (mA)	Voltage (V)	COD (mg O_2/L H_2O)	% Yield
0	18	900	5	18,100	0
1	22	900	5	11,200	38.12
2	29	900	5	7,800	56.91
3	37	900	5	6,700	62.98

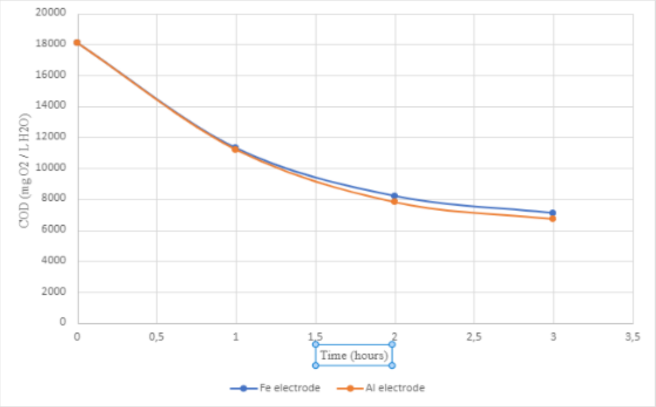

Figure 1; Diagram representing the comparison of COD reductions as a function of time for the 2 electrodes

Therefore, it is found that with time, the degree of pollutants removal increases, which happens in the first two hours of treatment. It is observed that after two hours the efficiency of the treatment is significantly reduced, because some of the chemical compounds contained in the waste cannot be removed by this process. For this reason, further investigation is needed to apply another method of treatment. It is worth noting that during the experiment the temperature of the waste increased. A part of the pollutants is brought to the top, as it is carried by the hydrogen produced in the cathode, while another part, due to the large flocculants generated, settles to the bottom as sludge under the effects of gravity. Finally, in the middle there was pure water.

Aknowledgements; The authors would like to thank professor D. Marmanis for his supervision.

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ΚΑΘΑΡΙΣΜΟΣ ΠΡΑΓΜΑΤΙΚΩΝ ΑΠΟΒΛΗΤΩΝ ΑΠΟ ΤΗ ΒΙΟΜΗΧΑΝΙΑ ΠΛΑΣΤΙΚΩΝ ΜΕ ΤΗΝ ΜΕΘΟΔΟ ΤΗΣ ΗΛΕΚΤΡΟΚΡΟΚΙΔΩΣΗΣ

Τα υγρά απόβλητα από βιομηχανίες πλαστικών μπορεί να καθαριστούν σε ποσοστό πάνω από 60% με ηλεκτροχημική επεξεργασία χρησιμοποιώντας ηλεκτρόδια σιδήρου και αλουμινίου. Η ηλεκτροκροκίδωση είναι κροκίδωση κατά την οποία τα κροκιδωτικά $Fe(OH)_3$ *και* $Al(OH)_3$*, δεν προστίθενται στο επεξεργαζόμενο διάλυμα αλλά δημιουργούνται επί τόπου μέσω ηλεκτροδιάλυσης της ανόδου από σίδηρο ή αργίλιο αντίστοιχα. Τα κροκιδωτικά εγκλωβίζουν και συσσωματώνουν τους ρύπους, οι οποίοι τελικά λόγω βαρύτητας καθιζάνουν.*

e-Poster

INVESTIGATION OF THE EFFECT OF SiO_2 MICROSPHERES PERCENTAGE ON MECHANICAL PROPERTIES WHEN ADDED TO POLYMERIC MATERIALS FOR USE IN ADDITIVE MANUFACTURING PROCESSES

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The study of the effect of SiO_2 microsphere percentage on mechanical properties when added to polymeric materials for use in additive manufacturing processes is an important topic in the development of high performance materials for 3D printing. The incorporation of microparticles, such as silica (SiO_2) microspheres, into polymer matrices can significantly modify the mechanical properties of the final material, including strength, hardness, toughness, and thermal stability. The production of a glass-polymer composite material suitable for printing products is of crucial importance in order to achieve the best possible result in polymer composition and in determining the maximum degree of filling percentage.

In [1], β-TCP powder and polyetherimide (PEI) were used as dispersion mediums. The materials were mixed and ground by ball milling with the addition of silica in various concentrations (0.0–1.5 wt% SiO_2). After drying and sieving, the powders were pressed and sintered. The results showed a decrease in shrinkage and an improvement in the density of the ceramics.

In this work, the synthesis of a mixture of PLA and SiO_2 beads with a content of 2%, 5%, and 15% w/w, respectively, was carried out. The mixtures of PLA and SiO_2 were mechanically stirred in order to produce a homogenised solution. Filaments with a diameter of 1.75 mm using pure PLA, and the mentioned mixtures were produced using a desktop extruder, applying the following process parameters: Screw speed: 3.5 RPM, temperature of heaters: between 170 and 188 °C. The produced filaments were used to manufacture cylindrical specimens for compression testing, using a FDM 3D printer (Bambu Labs Carbon X1). A layer height of 0.2 mm and hot end temperature of 210°C were applied during the printing of the specimens. The specimens had a diameter of 12 mm and a height of 24 mm. Four specimens for each filament were manufactured (pure PLA, mixtures of 2% / 5% / 15%). In figure 1, the extruder (on the left) and the produced specimens (on the right) are illustrated.

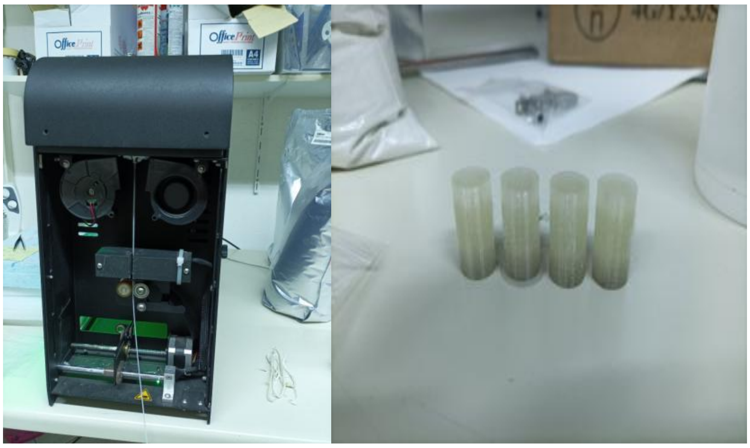

Figure 1 The extruder (on the left) and the produced specimens (on the right).

The compression tests of the specimens were carried out using a universal testing machine (UTM). During the test, the specimen is placed between two plates and pressed until it deforms or breaks. The forces and deformations are recorded in order to determine the mechanical properties of the material, such as its resistance to compression. The test was made according to the method described in ASTM D638 standard. The deformation rate was 2mm/min and compression was made until 50% of the sample height. Also, the preload was 20–25 N. Preloading is done in order to stabilise the machine. At the end of the testing process, the results shown in the diagram below were found. They show that the specimens with 5% w/w SiO_2 show higher resistance than even pure PLA. As expected, the other tests follow, with those with 15% w/w showing the lowest resistance. The 5% tests may have been more resistant because of the forces between the SiO_2 molecules. These forces don't appear in the 2% w/w tests because the low percentage of SiO_2 beads, while they are very high in the 15% w/w tests, making the beads fragile. The obtained stress – strain curves are shown in figure 2.

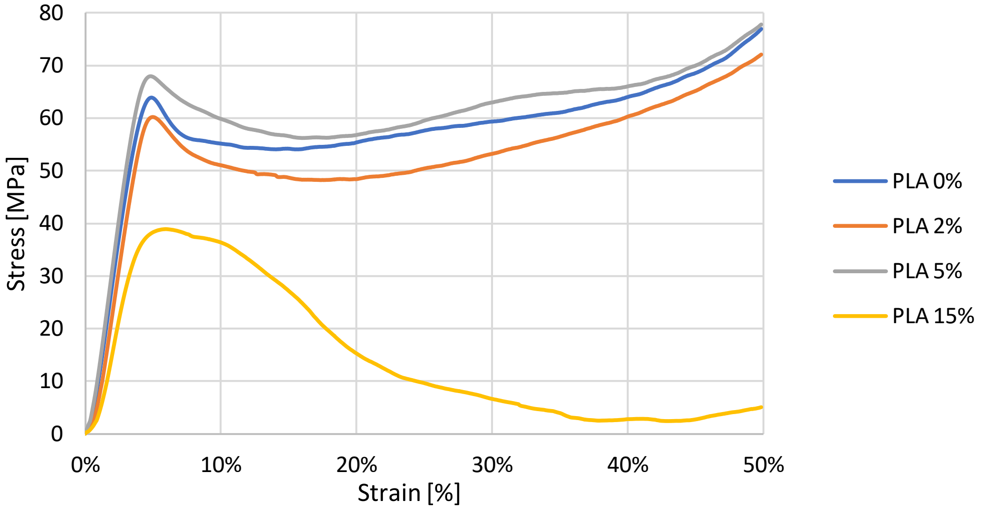

Figure 2 Stress – strain curves as determined from the compression tests.

Aknowledgements: The authors would like to thank Professor Dr. Eng. Georgios Maliaris for his supervision.

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ΔΙΕΡΕΥΝΗΣΗ ΤΗΣ ΕΠΙΔΡΑΣΗΣ ΤΟΥ ΠΟΣΟΣΤΟΥ ΜΙΚΡΟΣΦΑΙΡΙΔΙΩΝ SiO_2 ΣΤΙΣ ΜΗΧΑΝΙΚΕΣ ΙΔΙΟΤΗΤΕΣ ΚΑΤΑ ΤΗΝ ΠΡΟΣΘΗΚΗ ΣΕ ΠΟΛΥΜΕΡΙΚΑ ΥΛΙΚΑ ΓΙΑ ΧΡΗΣΗ ΣΕ ΔΙΕΡΓΑΣΙΕΣ ΠΡΟΣΘΕΤΙΚΗΣ ΚΑΤΑΣΚΕΥΗΣ

Η μελέτη της επίδρασης του ποσοστού των μικροσφαιριδίων SiO_2 *στις μηχανικές ιδιότητες των πολυμερών υλικών για την προσθετική κατασκευή καθίσταται σημαντική. Η ενσωμάτωση νανοσωματιδίων όπως τα μικροσφαιρίδια* SiO_2 *μπορεί να ενισχύσει την αντοχή, τη σκληρότητα, την ανθεκτικότητα και τη θερμική σταθερότητα του τελικού υλικού. Σε σχετική, σκόνη β-TCP και PEI χρησιμοποιήθηκαν ως μέσο διασποράς, αναμείχθηκαν με διοξείδιο του πυριτίου σε διάφορες συγκεντρώσεις και πυροσυσσωματώθηκαν μετά από ξήρανση και κοσκίνισμα. Τα αποτελέσματα έδειξαν μείωση της συρρίκνωσης και βελτίωση της πυκνότητας των κεραμικών, με το 1,0 % κ.β.* SiO_2 *να περιορίζει την ανάπτυξη των κόκκων και να αυξάνει την πυκνότητα, καθιστώντας τα κατάλληλα για τρισδιάστατη εκτύπωση κεραμικών.*

Στο πείραμα που διεξήχθη, συντέθηκε ένα μείγμα σφαιριδίων PLA και SiO_2 *με περιεκτικότητα 2% 5% και 15% κ.β., εξωθήθηκε σε νήμα πάχους 1,75 mm και εκτυπώθηκε τρισδιάστατα. Τα δοκίμια εξετάστηκαν ως προς την ικανότητά τους να παρουσιάζουν μικρές παραμορφώσεις πριν από τη θραύση. Η δοκιμή συμπίεσης έγινε σύμφωνα με το πρότυπο ASTM D638, με ρυθμό παραμόρφωσης 2mm/min και προφόρτιση 20-25N. Η συμπίεση έγινε μέχρι το 50% του ύψους του δείγματος για τον προσδιορισμό των μηχανικών ιδιοτήτων του υλικού, όπως η αντοχή του σε συμπίεση. Με το πέρας της διαδικασίας παρατηρείται πως τα δοκίμια με ποσοστό σφαιριδίων 5% παρουσιάζουν τη μεγαλύτερη αντοχή σε συμπίεση ενώ αυτά ποσοστού 15% τη μικρότερη. Η μεγάλη αντοχή δοκιμίων 5% περιεκτικότητας μπορεί να αποδοθεί στις δυνάμεις που ασκούνται μεταξύ των σφαιριδίων* SiO_2.

e-Poster

EXPLORING NEW FRONTIERS IN THE SYNTHESIS OF BIOACTIVE CHALCONE DERIVATIVES

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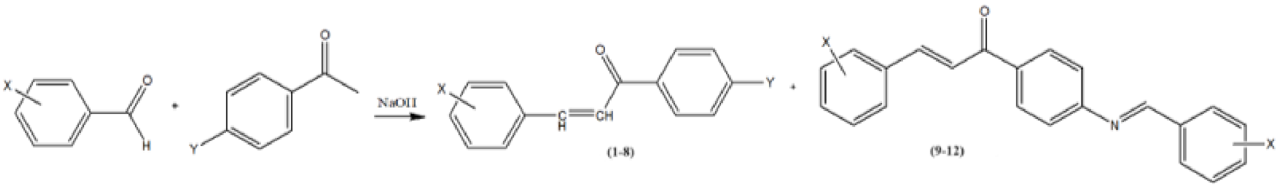
Chalcones, a type of flavonoid, are abundant natural products with significant biological importance. They have potential as antioxidants and cytotoxic and antiviral agents, sparking considerable interest and ongoing research [1]. Chalcone derivatives' structural simplicity and potential therapeutic applications have led to numerous syntheses reported in the literature [2]. Their unique structural framework makes them versatile molecules for developing and enhancing pharmaceuticals. Our current work aims to synthesize chalcone derivatives and investigate the synthetic method's influence on the resulting compounds' quantity and characteristics. To achieve our objective, various aromatic aldehydes and substituted acetophenones were subjected to a Claisen–Schmidt condensation reaction to form an α,β-unsaturated carbonyl compound, corresponding to the chalcone derivative. In addition to the conventional method, we explored the potential of environmentally friendly methods, such as sonication, UV radiation and grinding techniques, to enhance product yields and uncover possible alternative reaction pathways.

Synthesis of chalcone derivatives. Conventional method. Equal amounts (1,5 mmol) of aromatic aldehyde and acetophenone derivative were mixed in 95% ethanol (10 mL) and cooled in an ice bath for 5 minutes. Then, 0.2 mL of 40% sodium hydroxide solution in water was added dropwise. The mixture was stirred at room temperature for 30 minutes, poured into a beaker with crushed ice, and neutralized with 10% HCl. The resulting precipitate was collected, washed with cold water, and dried. If no precipitation was observed, the reaction mixture was extracted with dichloromethane to obtain the crude product. *Grinding technique*. The grinding process was performed by grinding together an equimolar mixture of aldehydes and acetophenones with pellets of sodium hydroxide in a mortar at room temperature for 20 minutes. The reaction mixture was worked up in the same way as described in the conventional method. *Sonication*. The mixture of raw materials was subjected to ultrasound irradiation in an ultrasound bath at room temperature for 30 minutes. *UV radiation*. The raw materials were prepared as per the grinding technique and then subjected to 20 minutes of ultraviolet (UV) irradiation at wavelengths of 365 nm and 254 nm simultaneously. The crude reaction mixture was analyzed using the Agilent 7000E triple quadrupole GC/MS without prior purification. The mass spectra were used to identify the organic compounds present, and all concentrations were determined based on relative area percentages.

Results and Discussion. Monitoring the progress of a reaction is essential in organic synthesis. In the case of complex reaction mixtures and isomeric products, thin-layer chromatography, which is often used, proves insufficient. In this paper, we report the use of GC-triple quadrupole MS/MS as a method for the unambiguous identification and differentiation of the desired chalcone isomers in the crude reaction mixture. The chalcones synthesized in the present study are shown in Figure 1.



Entry	1	2	3	4	5	6	7	8	9	10	11	12
X	H	4-OCH_3	3-NO_2	3-OCH_3 4-OH	H	4-OCH_3	3-NO_2	4-OH, 3-OCH_3	H	4-OCH_3	3-NO_2	4-OH, 3-OCH_3
Y	H	H	H	H	NH_2	NH_2	NH_2	NH_2	NH_2	NH_2	NH_2	NH_2

Figure 1. Synthesis Scheme of chalcone derivatives

The prepared compounds exhibit a variety of substituents at different positions of the aromatic rings. Chalcones can exist in trans (*s-cis* or *s-trans*) or cis isomeric forms, with the trans isomer being the predominant configuration. It is important to note that in some studied reactions, such as the reaction of 4-aminoacetophenone and benzaldehyde, ultrasound has been found to promote the isomerization of chalcone derivatives from *s-cis* to *s-trans*. GC chromatography analysis revealed multiple peaks, indicating the presence of coexisting isomers in the unpurified product mixture (Figure 2). In contrast, when using the grinding technique, the main product obtained was the unexpected Schiff base derivative 9. Schiff base derivatives are significant compounds used in biological and pharmacological studies and various industrial applications [3]. In the reaction between acetophenone and vanillin 4, the desired chalcone product was only obtained when UV radiation was used.

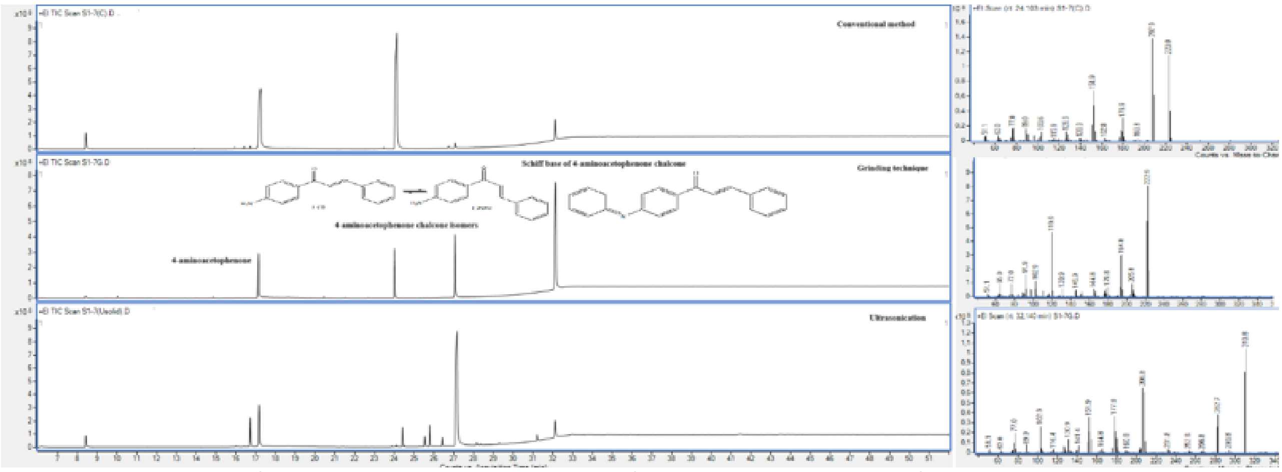


Figure 2. Comparison of the Total Ion Chromatograms (TIC) of the crude reaction mixture of 4-aminoacetophenone and benzaldehyde using conventional, grinding techniques and sonication, and the mass spectra of the main products

To conclude, some of the compounds that have been prepared are of significant interest due to their unique compositions not found in existing literature. Additionally, including methoxy, nitro, or amino groups in the aromatic rings in the Schiff bases chalcone derivatives shows excellent potential for antioxidant activity, making them suitable for further exploration in the development of new drugs and biological products. In most reactions studied, conventional and ultrasound methods yielded better results than grinding. The GC-MS analysis of the crude reaction mixture proved to be a powerful tool for monitoring the reaction and finding alternative synthetic pathways. The next step in this work will be to test a more extensive series of chalcone derivatives with unconventional preparation methods and use them as a 2π electron system in [4+2] cycloadditions with quinodimethane derivatives.

Aknowledgements: The authors would like to thank Professor S. Mitkidou for her supervision.

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ΔΙΕΡΕΥΝΗΣΗ ΝΕΩΝ ΣΥΝΘΕΤΙΚΩΝ ΜΟΝΟΠΑΤΙΩΝ ΒΙΟΔΡΑΣΤΙΚΩΝ ΠΑΡΑΓΩΓΩΝ ΧΑΛΚΟΝΗΣ

Οι χαλκόνες αποτελούν μια από τις πιο σημαντικές ομάδες φυσικών προϊόντων με ποικίλες βιολογικές και φαρμακολογικές δράσεις. Η δραστικότητά τους και η ευέλικτη χημική δομή τους τις καθιστά ιδανικά μόρια για τη σύνθεση νέων ενώσεων με επιθυμητές βιοδραστικές ιδιότητες. Στην παρούσα εργασία αναφέρεται η σύνθεση και ο χαρακτηρισμός νέων παραγώγων χαλκονών με συμβατικές αλλά και πράσινες μεθοδολογίες σύνθεσης. Η εφαρμογή υπερήχων, υπεριώδους ακτινοβολίας και τεχνικών άλεσης οδήγησε στη σύνθεση νεών στερεοϊσομερών χαλκονών και στον σχηματισμό βάσεων του Schiff σε σημαντικές αναλογίες. Οι ενώσεις που παρασκευάστηκαν εμφανίζουν ποικιλία υποκαταστατών σε διαφορετικές θέσεις των αρωματικών δακτυλίων. Η χρήση της αέριας χρωματογραφίας φασματομετρίας μάζας (GC-MS) στη μελέτη του ακατέργαστου μείγματος αντίδρασης αποδείχθηκε ένα ισχυρό εργαλείο για την παρακολούθηση της αντίδρασης και την εύρεση εναλλακτικών συνθετικών οδών.

e-Poster

SYNTHESIS AND STUDIES OF GREEN CARBON DOTS FROM ORANGES AS SENSORS FOR FAST MONITORING THE POLARITY OF SOLVENTS

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A problem that plagues today's researchers is the fast and precise monitoring of solvent polarity, because it affects reaction kinetics, solubility, as well as molecular conformation during the interaction in a chemical process. Moreover, in biological systems, polarity is vital for establishing and reflecting a large number of sophisticated physiological functions and pathological effects. The polarity of a solution can be determined by several methods either using laboratory equipment or through polarity detectors. More specifically, laboratory methods include Karl Fischer titration and gas chromatography. In biological systems polarity sensing can be performed via transmission electron microscopy. However, these methods require skilled operators, specific reagents, and prolonged measurement time. In contrast, fluorescent sensors crafted from nanoparticles exhibit outstanding biological affinity and distinctive photoelectric properties. These benefits render carbon dots exceptional for the real-time detection and imaging in polarity response. [1]

For the aforementioned reasons, this project is focused on utilizing carbon dots (**CDs**) as fluorescent sensors derived from orange peels and orange juice. The preference for biomass-based carbon source over small molecules was driven by their cost-effectiveness, environmental friendliness, and widespread availability (***Figure 6***). [2]

The experimental procedure was conducted as follows. The orange peels were thoroughly washed and placed in an ultrasonic bath at room temperature for 3 minutes. Next, the peels were heated at 70 ^{o}C before being pulverized. 2 g of the resulting powder were added to 20 mL of deionized water and sonicated for 30 minutes. The mixture was then poured into a 25 mL stainless steel autoclave lined with Teflon and heated at 180 ^{o}C for 8 hours, after that the reactor left to reach room temperature, overnight. The mixture was centrifuged at 4000 rpm in order to remove large particles. Then, the orange liquid was placed in a semi-permeable membrane filter of 1 KDa in order to remove low molecular weight particles. The filtered liquid was freeze dried in order to obtain a light yellow solid. The overall yield was 1.5 %.

In the case of the juice, 40 mL of orange juice was used and a large portion of the solid residues were removed via filtration. Due to the presence of impurities, the juice was subjected to centrifugation at 4000 rpm for 5 minutes, and then left to rest for around 24 hours. Afterwards, the samples were spun in a centrifuge for 1 h until the solutions became completely clear, forming two layers. The juice was placed in an autoclave at 180 ^{o}C for 2.5 hours and it was left to reach room temperature, overnight. Then, 9.8 mL of the liquid was purified through a membrane of 1 KDa, freeze dried in order to obtain the final CDs in 1.3 % yield.

The materials were characterized with UV-Vis, Nanosight, FT-IR and SEM techniques (***Figures 1-3***). For the UV-Vis analysis, the green carbon dots were dissolved in different mixtures of water and EtOH varying their proportion. Upon UV irradiation the **CDs** emitted different colors depending on the different polarities of the mixtures. All samples were analyzed with UV-Vis spectroscopy, where comparable absorbance peaks were noted for both **CDs**, despite a notable variance in absorbance intensity (***Figures 4-5***). This alteration is likely to be arising from the distinct compositions of the initial materials, particularly the occurrence of hydrogen bonds and the presence of ascorbic acid in the orange juice.[3] A gel composed of agar-agar was developed by dissolving the **CDs** in deionized water. Subsequently, the gel was exposed to UV lamp in order to assess its photoluminescence. This approach has the potential for qualitative determination of moisture content in liquids.

To summarize, **CDs** from orange waste were produced via hydrothermal condition without adding chemicals and characterized with several analytical methods. This procedure is a facile, eco-friendly method, which may be practicable for large scale production. It was observed that **CDs** from juice had higher absorbance in UV and IR than the **CDs** from peels, due to difference in compositions. Green **CDs** could be utilized in sensing polarity, metal ions, organic molecules and in vitro or in vivo imaging applications of plant and animal cells. Considering their exclusive composition of natural raw materials, these products offer new opportunities for utilization in cosmetics and food industries.

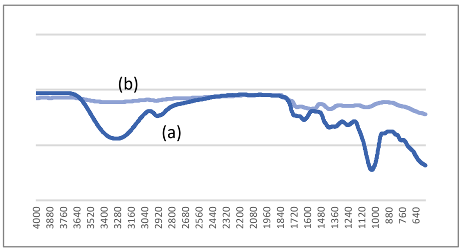

***Figure 1**. FT-IR spectra of (a) CDs from orange juice, (b) CDs from orange peels.*

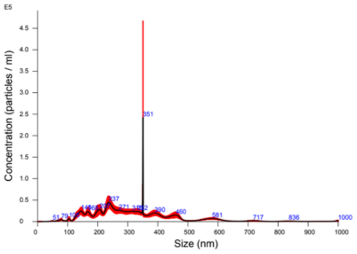

***Figure 2.** Nanosight image of CDs.*

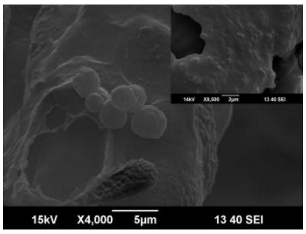

***Figure 3.** SEM images of CDs.*

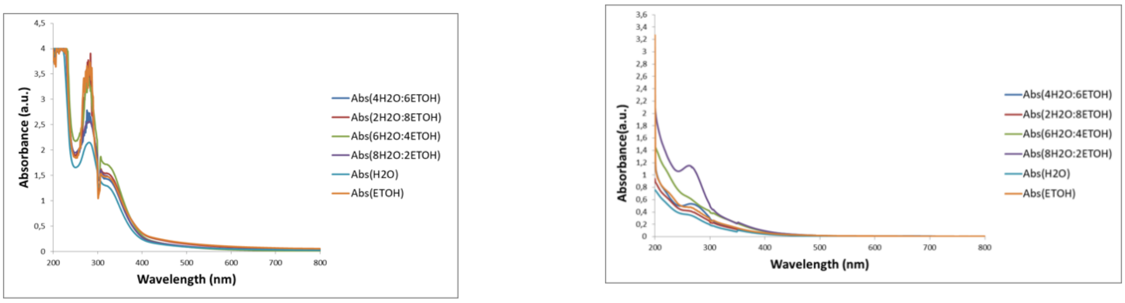

***Figure 4.** Absorption spectra of CDs from orange juice (left) and orange peels (right) in different mixtures of H_2O-EtOH.*

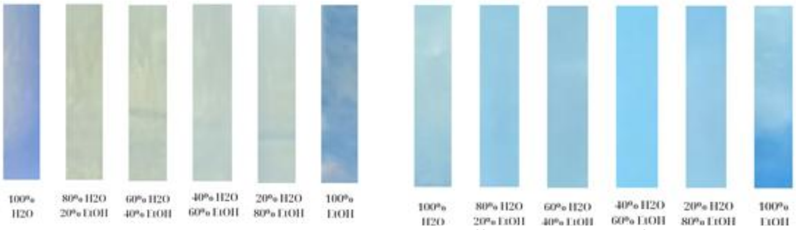

***Figure 5.** Colors emitted under UV lamp due to different mixtures of EtOH-H_2O, orange juice (left) and CDs from orange peels (right).*

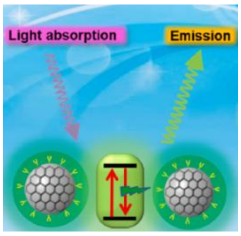

***Figure 6.** Schematic diagram showing CDs from photoluminescence of CDs.*

Key-words: green carbon dots, orange juice, orange peels, solvent polarity, sensors

Acknowledgements: The authors would like to thank Dr. K. Ladomenou for her supervision.

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ΣΎΝΘΕΣΗ ΚΑΙ ΜΕΛΈΤΕΣ ΠΡΆΣΙΝΩΝ ΤΕΛΕΙΩΝ ΆΝΘΡΑΚΑ ΑΠΌ ΠΟΡΤΟΚΆΛΙΑ ΩΣ ΑΙΣΘΗΤΉΡΕΣ ΓΙΑ ΤΗΝ ΤΑΧΕΊΑ ΠΑΡΑΚΟΛΟΎΘΗΣΗ ΤΗΣ ΠΟΛΙΚΌΤΗΤΑΣ ΤΩΝ ΔΙΑΛΥΤΩΝ

Η πολικότητα ενός διαλύτη διαδραματίζει καθοριστικό ρόλο σε μια χημική διεργασία, λόγω των σημαντικών ιδιοτήτων που επηρεάζει. Για αυτό το λόγο, η παρακολούθηση πολικότητας των διαλυτών σε πραγματικό χρόνο είναι ένα πρόβλημα που ταλανίζει τους σημερινούς ερευνητές. Στην παρούσα εργασία, με αφορμή τον παραπάνω προβληματισμό και με την προσδοκία μίας πιο πράσινης προσέγγισης επί του θέματος, συντέθηκαν τελείες άνθρακα από βιομάζα και συγκεκριμένα από τη φλούδα και το χυμό πορτοκαλιού μέσω υδροθερμικής μεθόδου και στη συνέχεια ακολούθησαν αναλυτικές τεχνικές UV-Vis, IR, Nanosight και SEM για το χαρακτηρισμό τους. Τέλος, εξετάστηκε η εφαρμογή τους ως ανιχνευτές πολικότητας για διαλύματα με διαφορετικές αναλογίες πολικών διαλυτών κάτω από λάμπα υπεριώδους.

e-Poster

PRODUCTION AND CHARACTERIZATION OF BIOFUEL FROM NON-EDIBLE BIOMASS

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Global reliance on fossil fuels has led to significant environmental and economic challenges. Biodiesel, a promising renewable and low-carbon substitute for traditional diesel fuel in transportation, is derived from various renewable sources, such as vegetable oils, animal fats, and waste cooking oils (WCOs), through transesterification. In this process, oils or fats react with an alcohol, typically methanol or ethanol, in the presence of a catalyst, forming fatty acid methyl or ethyl esters (FAME and FAEE), commonly known as biodiesel. Homogeneous alkaline catalysts, like sodium hydroxide (NaOH), are widespread in industrial-scale biodiesel production. The recycling of WCO to produce biodiesel reduces waste and provides a clean energy source that can aid in diversification. Biodiesel, when used as a cleaner-burning alternative to traditional diesel fuel in diesel engines, offers environmental benefits such as reduced air pollutants and greenhouse gas (GHG) emissions [1,2].

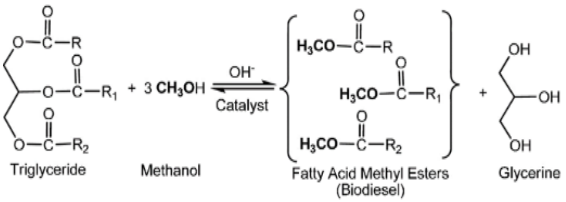


Figure 1. Alkali-catalyzed transesterification of triglycerides to FAMEs.

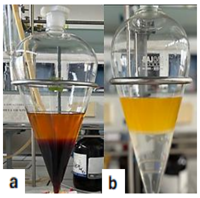


Figure 2. a) Biodiesel-glycerol, b) biodiesel-water.

The experimental part of this research included the production of biodiesel from a WCO sample derived from a local restaurant, its characterization using the well-established methods outlined in the EN 14214 standard and its FAMEs composition using gas chromatography-mass spectrometry (GC-MS) technique. As the measured acid value (AV) of the WCO sample was found below 2 mg KOH/g oil (0, 615), 500 mL of purified WCO was directly transesterified with 4.61 g NaOH dissolved in 127.5 mL of methanol at a temperature of 55–58 °C for 60 to 70 minutes in a two-neck spherical flask with continuous stirring. Afterward, the reaction mixture was transferred to a separatory funnel to receive the produced FAMEs (upper phase) and the glycerol (lower phase) (Fig 2a). After glycerol removal, biodiesel was washed with hot deionized water to remove any impurities (Fig. 2b). Finally, the volume of purified biodiesel was 455 mL, and the yield was calculated as 87.27% (Fig.2).

Table 1 shows the measured properties of the WCO sample, while *Table 2* shows the most critical properties of obtained biodiesel outlined by EN ISO standards.

Table 1. Measured properties of WCO.

Property	WCO	Test Method
Density at 15°C, g·cm^{-3}	0.9245	EN ISO 12185
Water content, mg·kg^{-1}	1210.9	EN ISO 12937
Acid number, mg KOH·g^{-1}	0.615	EN ISO 14104

Table 2. Measured properties of biodiesel.

Property	BD	Specs EN 14214	Test Method
Density at 15°C, g·cm^{-3}	0.8866	0.86-0.91	EN ISO 12185
Viscosity 40 °C, mm^2·sec^{-1}	4.83	3.5-5.0	EN ISO 3104
Water content, mg·kg^{-1}	460.9	< 500	EN ISO 12937
Acid number, mg KO H·g^{-1}	0.42	< 0.5	EN ISO 14104
Sulfur, mg·kg^{-1}	2.28	< 10	EN ISO 20846
Flash Point, °C	>120	>120	EN ISO 3679
CFPP, °C	-2.0	Country Specific Max. +5°C	EN 116
Oxidative stability at 110 °C, h	0.18	> 8	EN 14112
Iodine Value, g I_2/100	118.6	< 120	EN 14111

The results in Table 2 indicated that all biodiesel properties met the specifications outlined in the EN 14214 standards properties except for oxidative stability, which is an indicator of biodiesel quality and performance characteristics when stored for extended periods. Density is a fundamental fuel property, directly impacting an engine's performance characteristics, while viscosity is a physical property of fluids that signifies their resistance to flow. Additionally, the presence of water in fuel significantly affects fuel quality, while AV measurement offers valuable insights into the acidity levels of biodiesel. Flash point (FP) is also a critical physicochemical attribute essential in gauging the likelihood of fire and explosion, particularly for hazardous substances like fuels. Another important parameter is the cold filter plugging point (CFPP), which is country-specific and is used to evaluate a fuel's

Table 3. FAMEs composition and retention times.

capacity to operate efficiently in cold conditions without the risk of fuel filter blockage caused by the crystallization of wax. The acceptable maximum values in Greece are -5^{o}C and +5^{o}C for the winter and summer, respectively. The iodine value (IV) indicates the overall unsaturation of biodiesel, and EN 14214 establishes a maximum limit of 120 grams of iodine absorbed per 100 grams of biodiesel (g I_2/100 g). All the above properties met the requirements outlined by EN 14214 methods for biodiesel.

Besides the physical characteristics of biodiesel, its chemical composition is equally essential in evaluating its quantity and quality. The GC-MS (EN 14103) total ion chromatograph (TIC) chromatograph for the biodiesel sample showed that the most abundant FAMEs were the linoleic acid (C18:2) methyl ester and oleic acid (C18:1) methyl esters (49.8% and 37.72%, respectively). Saturated fatty acids methyl esters, such as C16:0 and C18:0, were also found, but in lesser amounts (Fig. 3). The specific composition in FAMEs and the retention times of FAMEs shown in Table 3.

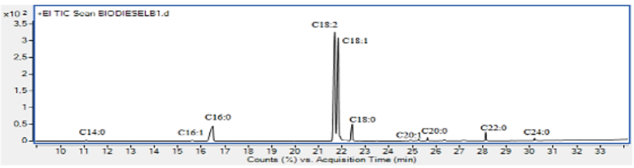
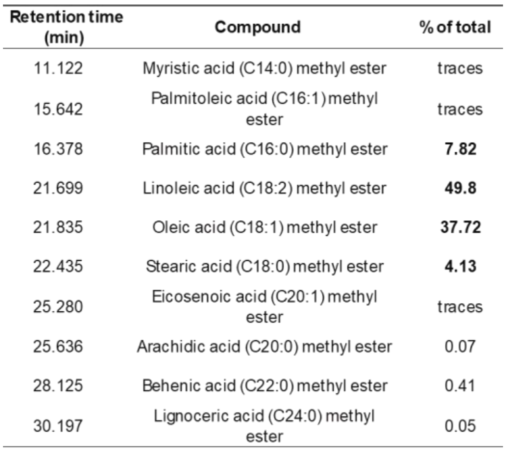


Figure 3. GC-MS TIC chromatograph of biodiesel.



Retention time (min)	Compound	% of total
11.122	Myristic acid (C14:0) methyl ester	traces
15.642	Palmitoleic acid (C16:1) methyl ester	traces
16.378	Palmitic acid (C16:0) methyl ester	**7.82**
21.699	Linoleic acid (C18:2) methyl ester	**49.8**
21.835	Oleic acid (C18:1) methyl ester	**37.72**
22.435	Stearic acid (C18:0) methyl ester	**4.13**
25.280	Eicosenoic acid (C20:1) methyl ester	traces
25.636	Arachidic acid (C20:0) methyl ester	0.07
28.125	Behenic acid (C22:0) methyl ester	0.41
30.197	Lignoceric acid (C24:0) methyl ester	0.05

Acknowledgments: The authors would like to thank N. C. Kokkinos, A. Lazaridou and E. Emmanouilidou for their support and supervision.

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ΠΑΡΑΓΩΓΗ ΚΑΙ ΧΑΡΑΚΤΗΡΙΣΜΟΣ ΒΙΟΚΑΥΣΙΜΟΥ ΑΠΟ ΜΗ-ΒΡΩΣΙΜΗ ΒΙΟΜΑΖΑ

Για την αντιμετώπιση της κλιματικής αλλαγής προτείνεται η μετάβαση από τα συμβατικά ορυκτά καύσιμα προς πιο φιλικές προς το περιβάλλον εναλλακτικές λύσεις, όπως τα βιοκαύσιμα που παράγονται από μη βρώσιμη βιομάζα, όπως το χρησιμοποιημένο μαγειρικό λάδι (WCO). Στην παρούσα εργασία διερευνάται η σύνθεση βιοντίζελ από ένα δείγμα WCO μέσω της βασικά καταλυόμενης αντίδρασης μετεστεροποίησης, η μελέτη των σημαντικότερων ιδιοτήτων του και η σύστασή του σε FAMEs. Αρχικά, με εργαστηριακές μετρήσεις χαρακτηρίστηκε η πρώτη ύλη (πυκνότητα, υγρασία και αριθμός οξύτητας) και στη συνέχεια το παραγόμενο βιοντίζελ (πυκνότητα, υγρασία, ιξώδες, αρ. οξύτητας, θείο, σημείο ανάφλεξης, CFPP, οξειδωτική σταθερότητα και αριθμός ιωδίου). Έπειτα πραγματοποιήθηκε ποιοτικός και ποσοτικός προσδιορισμός του παραγόμενου βιοντίζελ σε μεθυλεστέρες (FAMEs) με τη μέθοδο της αέριας χρωματογραφίας συζευγμένη με φασματομετρία μάζας GC-MS. Τα αποτελέσματα επιβεβαίωσαν ότι το παραγόμενο βιοντίζελ πληροί ως επί το πλείστον τις βιομηχανικές προδιαγραφές που ορίζει το ευρωπαϊκό πρότυπο EN 14214. Η εν λόγω έρευνα όχι μόνο ενθαρρύνει τη βιώσιμη παραγωγή καυσίμων, αλλά επικεντρώνεται και στη διαφοροποίηση των πηγών βιομάζας, στη δημιουργία ενεργειακής ασφάλειας και στη διασφάλιση της περιβαλλοντικής βιωσιμότητας.

e-Poster

PRODUCTION AND PROPERTIES DETERMINATION OF CONVENTIONAL FUELS FROM REAL PETROLEUM DISTILLATES

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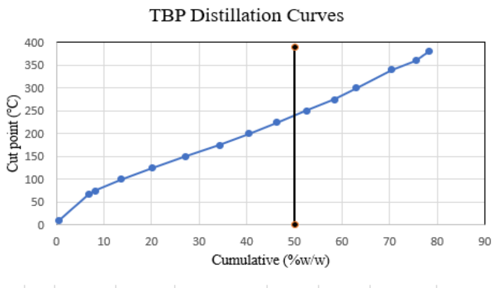
Crude oil is typically extracted from underground reservoirs through drilling operations. Initially, fraction distillation of crude oil takes place adhering to standard experimental instrumentation, such as Eurodist, and experimental procedures outlined by ASTM D-2892. This method involves heating a sample of petroleum distillate in a distillation apparatus, causing it to vaporize and condense into different fractions based on their boiling points. Important characteristics are measured using standardized methods established by organizations such as ASTM International and the American Petroleum Institute (API). For Kazakhstan's crude oil (net weight 2405.8 g, gross weight 4553.4 g, pour point 15°C and humidity 414.8 ppm), the octane number, the flash point, the API gravity, the sulfur content, the cloud point and the pour point, as well as the mixing fractions (1-2,3-4,5-6,7-8,9-10,11-12,13-14) and the mixing fractions of the preceding fractions (1-6, 9-12) were successfully determined. The primary obstacles to the aforementioned process were: i) the extreme experimental conditions (high temperatures for organic samples) ii) small scale laboratory column to industrial scale iii) sample stabilization and management iv) maintaining the column's ideal temperature and pressure v) the requirement to monitor temperatures at various points (oil, column, and fraction collection).

A full stock property determination of Kazakhstan's crude oil was carried out in our lab according to ASTMD-2892. In order to fully utilize Kazakhstan's non-renewable crude oil, a methodical and resource-efficient distillation process was developed, achieving optimal use, reducing waste, and increasing yield. A wide range of valuable components were recovered from the crude oil by careful fractionation and temperature control. Furthermore, these cuts were converted into extremely effective fuels ensuring a high degree of worth and utilization of the raw material. A fractionation column, a top condenser, and a specially made glass flask with thermocouples inserted were used in the distillation process. A 2.5 L sample of stabilized crude petroleum is subjected to distillation at a maximum temperature of 400 °C AET. At 100% reflux, the fractionating column can operate with an efficiency of 15 theoretical plates. With the exception of the lowest pressures (0.674 to 0.27 kPa), where a 2:1 ratio is optional, a 5:1 reflux ratio is always maintained during operation. It is required to have prior agreement on operational settings. Frequent observations are performed, fractions are gathered and quantified, and yields are computed using density and mass. Fractionation is possible from 15 °C to 420 °C AET at pressures as low as 1 Torr when using the ASTM D-2892 technique. The procedure runs automatically, passing through several vacuum stages to go from ambient pressure to at least 1 Torr. Fractions are gathered in receivers that are either adjusted to -60°C or cooled with dry ice. Two gas traps are utilized to capture butane. Taking into account the above, Kazakhstan's crude oil belongs to a paraffin base with low sulfur percentage (0.60 %w/w), API gravity value 44.68° and low density (0.808 g/cm³). According to Figure 2, it is concluded that 50 % of the mixture has distilled at a temperature lower than 250 °C, which is cost-effective for the refinery.



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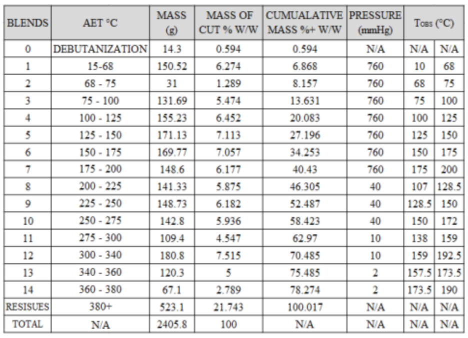

BLENDS	AET °C	MASS (g)	MASS OF CUT % W/W	CUMUALATIVE MASS %+ W/W	PRESSURE (mmHg)	TOBS (°C)	
0	DEBUTANIZATION	14.3	0.594	0.594	N/A	N/A	N/A
1	15-68	150.52	6.274	6.868	760	10	68
2	68 - 75	31	1.289	8.157	760	68	75
3	75 - 100	131.69	5.474	13.631	760	75	100
4	100 - 125	155.23	6.452	20.083	760	100	125
5	125 - 150	171.13	7.113	27.196	760	125	150
6	150 - 175	169.77	7.057	34.253	760	150	175
7	175 - 200	148.6	6.177	40.43	760	175	200
8	200 - 225	141.33	5.875	46.305	40	107	128.5
9	225 - 250	148.73	6.182	52.487	40	128.5	150
10	250 - 275	142.8	5.936	58.423	40	150	172
11	275 - 300	109.4	4.547	62.97	10	138	159
12	300 - 340	180.8	7.515	70.485	10	159	192.5
13	340 - 360	120.3	5	75.485	2	157.5	173.5
14	360 - 380	67.1	2.789	78.274	2	173.5	190
RESISUES	380+	523.1	21.743	100.017	N/A	N/A	N/A
TOTAL	N/A	2405.8	100	N/A	N/A	N/A	N/A

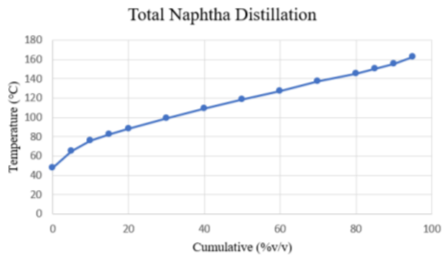

Figure 3 Total naphtha distillation (Recovery: 97.6 %v/v, Distillation residue: 0.7 %v/v)

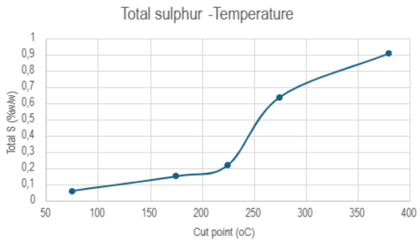

Figure 3 Total sulphur concentration in function with temperature

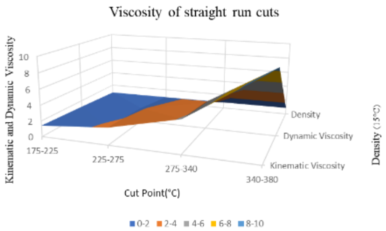

Figure 4 Kinematic viscosity, dynamic viscosity and density of the straight run cuts in function with temperature

Table 2 Properties of the blends of straight run cuts. (*N/A: Not available or not applicable, SG: Specific Gravity, DVPE: Dry Vapour Pressure Equivalent, ASVP: Air Containing Vapour Pressure, CN: Cetane Number, CI: Cetane Index*)

AET °C	STRAIGHT RUN CUTS	DESTILLATES	MASS PERCENTAGE % w/w	DENSITY (15°C)	SG (60/60°F)	DVPE	ASVP	RON	MON	AKI	C.N.	C.I.	SATURATES (MASS%)	OLEFINS (MASS%)	AROMATICS (MASS%)	CLOUD POINT °C	POUR POINT °C	S(w/w) ppm	METHOD
DEBUTANIZATION	GAS	GAS	0.594	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
15-68	LIGHT NAPHAS	NAPHTHAS	33.659	0.7288	0.729	31.6	36.7	84.6	78	81.3	N/A	N/A	85.9	3.7	10.4	N/A	N/A	0.06 (600)	ASTM D5453
68 - 75																			
75 - 100	MEDIUM NAPHTHAS																	0.15 (1500)	ASTM D4294
100 - 125																			
125 - 150	HEAVY NAPHTHAS																		
150 - 175																			
175 - 200	KEROSENES	KEROSENES	12.052	0.7989	0.7996	N/A	N/A	N/A	N/A	N/A	49.8	57.2	N/A	N/A	29.6	N/A	N/A	0.22 (2200)	ASTM D4294
200 - 225																			
225 - 250	LIGHT GASOILS	GASOILS	24.18	0.833	0.8333	N/A	N/A	N/A	N/A	N/A	53.5	56.1	N/A	N/A	18.1	5.9	-24	0.64(6400)	ASTM D4294
250 - 275																			
275 - 300	HEAVY GASOILS																		
300 - 340																			
340 - 360	VACUM GASOILS	VACUM GASOILS	7.789	0.8838	0.8846	NA	NA	NA	NA	NA	50.3	54.7	N/A	N/A	20.5	19.4	N/A	0.91(9100)	ASTM D4294
360 - 380																			
380+	RESIDUES	RESIDUES	21.743	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Acknowledgement: The authors would like to thank N. Kokkinos, A. Lazaridou, and E. Emmanouilidou for their support and supervision.

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ΠΑΡΑΓΩΓΗ ΚΑΙ ΠΡΟΣΔΙΟΡΙΣΜΟΣ ΙΔΙΟΤΗΤΩΝ ΣΥΜΒΑΤΙΚΩΝ ΚΑΥΣΙΜΩΝ ΑΠΟ ΠΡΑΓΜΑΤΙΚΑ ΑΠΟΣΤΑΓΜΑΤΑ ΠΕΤΡΕΛΑΙΟΥ

Το αργό πετρέλαιο αποτελεί έναν μη ανανεώσιμο ενεργειακό πόρο, καθιστώντας έτσι την αξία του υψηλή. Ακριβώς για αυτό το λόγο, θα πρέπει να διασφαλίζεται η αποδοτική μεταποίηση του σε καύσιμα και η πλήρη αξιοποίηση του με όσο το δυνατό λιγότερα παραπροϊόντα. Συγκριτικές μελέτες παραγωγής καυσίμων του αργού πετρελαίου, δίνουν πληροφορίες για τη σύνθεση των καυσίμων από απευθείας κλάσματα σύμφωνα με την Eurodist και την πειραματική διαδικασία ASTM D-2892 για τη βέλτιστη αξιοποίηση τους. Στα πλαίσια της παρούσας ερευνητικής εργασίας επετεύχθη παραγωγή καυσίμων σε εργαστηριακή κλίμακα από πραγματικό αργό πετρέλαιο του Καζακστάν καθώς και πλήρης ποιοτικός έλεγχος τους, σύμφωνα με τα βιομηχανικά πρότυπα. Συγκεκριμένα, αρχικά διαχωρίστηκαν 15 κλάσματα του μίγματος αργού πετρελαίου σύμφωνα με το σημείο βρασμού τους με χρήση της πλήρως αυτοματοποιημένης Eurodist κλασματικής στήλης. Έπειτα, πραγματοποιήθηκε η σύνθεση καυσίμων από τα απευθείας κλάσματα και προσδιορίστηκαν οι ιδιότητές τους κατά τα πρότυπα ASTM-EN. Λαμβάνοντας υπόψη τα αποτελέσματα της εργασίας μας, το αργό πετρέλαιο χαρακτηρίστηκε ως παραφινικής βάσης με χαμηλή περιεκτικότητα σε θείο (0,60 % w/w) και χαμηλή πυκνότητα (0,808 g/cm^3 με API 44,68^o). Σύμφωνα με την Εικόνα 2, μπορούμε να συμπεράνουμε ότι το 50 % του μείγματος έχει αποστάξει σε θερμοκρασία χαμηλότερη των 250°C, που αποτελεί τιμή τεχνοοικονομικά συμφέρουσα για τη βιομηχανία.

e-Poster

EFFECT OF NANOBUBBLES ON THE FORMATION OF MICELLES

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Surfactance in aqua solutions are known to lower the surfance tension (γ) of water. To this end they are widely used in both industrial and household processes [1]. Sodium dodecyl sulfate (SDS) is an anionic surface-active agent of this kind; $C_{12}H_{25}NaO_4S$ with a molecular weight of 288.38 g/mol. Critical micelle concentration (cmc) refers to the point where micelle formation begins; in the case of SDS cmc is given in the literature as $7.24x10^{-3}$mol/L [2]. By plotting γ versus the logC, where C is the concentration of the surfactant, the cmc may be obtained. From the slope (S) of the tangential line of the curve close to cmc the area (A) of the molecule can be calculated: $A = RT/N_AS$, where R is the gas constant, T is the absolute temperature, and N_A is the Avogadro number, likewise, the molar Gibbs free energy ΔG_m is given by [1]:

$$\Delta G_m = RTln(cmc)$$

In the past few years, nanobubbles (NBs) are also widely used in industry in order to intensify the processes. Nanobubbles are gaseous cavities having sizes of about 200nm. According to Young-Laplace equation they shouldn’t exist for more than a few ms; however they do exist for weeks even months [3].

In this study, the effect of NBs on the formation of SDS micelles was examined. SDS (Sigma-Aldrich® Brand) of purity > 99.0% was used. A standard solution of C=3000ppm was prepared by dissolving 3g of SDS in ultra pure water. A number of dilutions were carried out, taking appropriate quantities from the standard solution; 14 solutions have been prepared plus a blank one. The surface tensions of the solutions were measured by the hanging drop method at 25°C. A similar procedure was carried out for an equal number of aqua solutions with SDS and NBs. Nanobubbles having sizes of 285,2nm and concentration of $7.31x10^7$NB/mL were prepared by a NBs generator described elsewhere [3].

Figure 1 shows the result. The cmc for the solution without NBs was found equal to $7.74x10^{-3}$moles/L and with NBs $6.93x10^{-3}$moles/L, corresponding to 19.6$Å^2$ and 42.0$Å^2$, respectively. The Gibbs molar free energy was found for both cases equal to about -12kJ/mol.

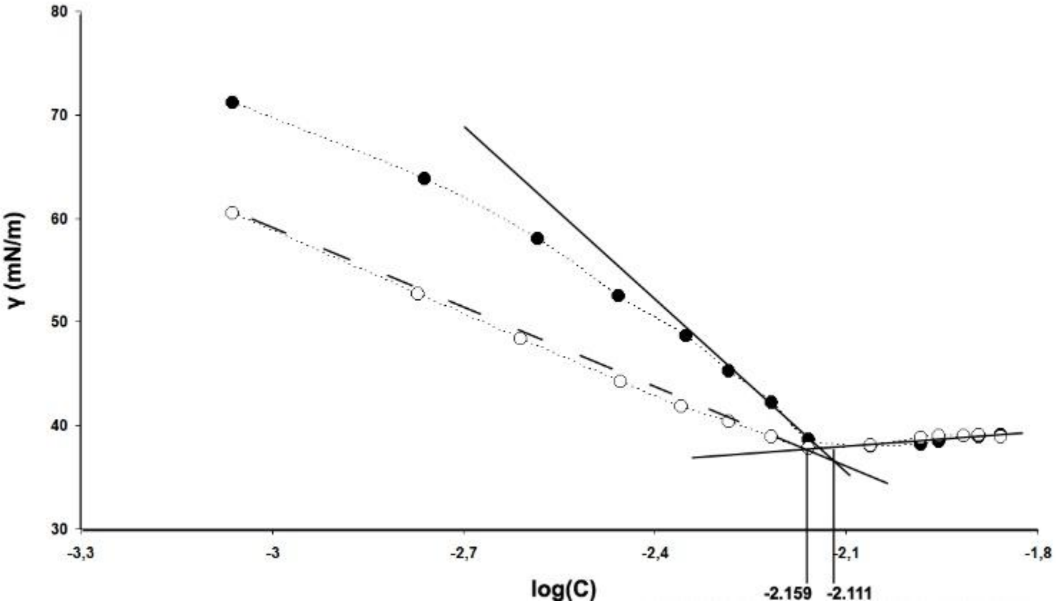

Fig.1: Determination of cmc for SDS without NBs (solid line and solid dots) and SDS with NBs (broken line and open dots).

The difference in the size of the molecule suggests that NBs facilitated the development of a double electrical layer capturing Na^+ ions. Since many monomers are attached around the NB, near cmc, the attraction of the anionic micelle by Na^+in the diffused layer is not strong enough to hold it. As a result, the micelle together with Na^+ is detached from the NB; hence an increase of the size of the molecule is obtained. Figure 2 illustrates the mechanisms.

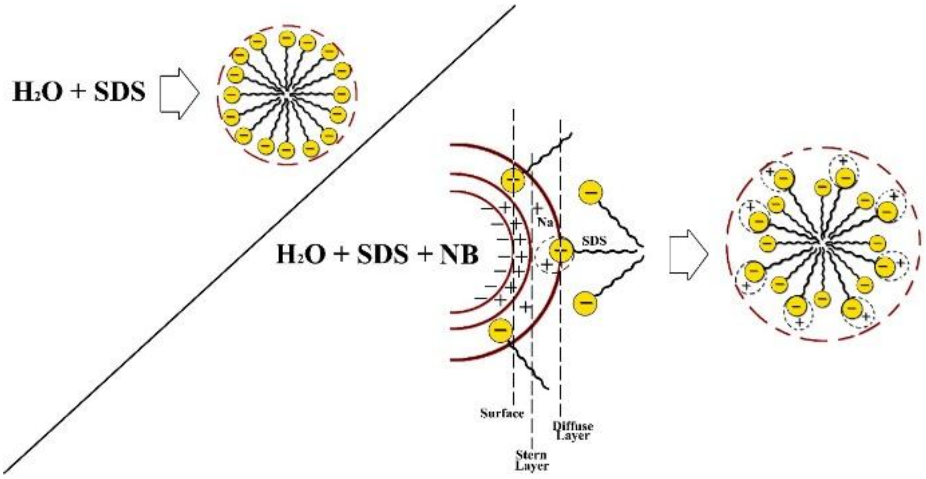

Fig.2: The mechanism of the increase of the size of the molecule by capturing Na^+ from the diffuse layer of the NB.

Since ΔG_m is equal in both cases it was inferred that NBs does not substantially change the cmc. What actually changes is the reduction of the surface tension by the presence of NBs indicating a smaller amount of surfactant to be used and hence a mild cleaning and washing is possible. Figure 3 shows the % reduction of the required surfactant.

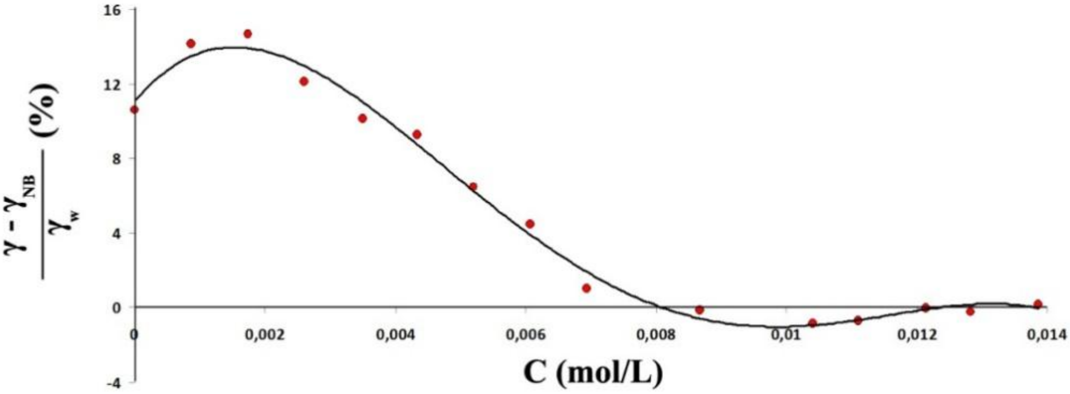

Fig.3 Surfance tension reduction (%) by using NBs

Acknowledgments: We would like to thank our Prof. A. Ch. Mitropoulos and Dr. R. Kosheleva for the support.

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Η ΕΠΙΔΡΑΣΗ ΤΩΝ ΝΑΝΟΦΥΣΑΛΙΔΩΝ ΣΤΟΝ ΣΧΗΜΑΤΙΣΜΟ ΜΙΚΥΛΛΙΩΝ

Στην παρούσα εργασία μελετήθηκε η επίδραση των νανοφυσαλίδων (NBs) στην συμπεριφορά του ανιονικού επιφανειοδραστικού, θειικού δωδεκύλιουτου νατρίου (SDS).Τα αποτελέσματα έδειξαν πως ενώ οι NBs δεν επηρεάζουν σημαντικά την cmc (critical micelle concentration) του επιφανειοδραστικού, προκαλούν μείωση της επιφανειακής τάσης του νερού από αυτή που θα συνέβαινε με μόνη την παρουσία του SDS στο διάλυμα. Προκύπτει, ότι οι NBs μπορούν να χρησιμοποιηθούν για την επίτευξη ενός αποτελεσματικότερου, ηπιότερου και οικονομικότερου προϊόντος καθαρισμού.

PLA Adhesion - Tensile Testing

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Due to the ongoing environmental crisis, scientists have been searching for a more eco-friendly but also economic alternative to petro-chemical sourced polymers. PLA (polylactic acid), as a popular candidate, is a high-strength, high-modulus thermoplastic which comes from the naturally occurring lactic acid and can be used in many fields such as the packaging industry, and the biomedical field due to it being bioabsorbable. It can also be processed in standard plastic equipment to produce film, fibers or molded parts. As PLA has many applications and is a candidate to replace traditional plastics, it is important to investigate the most suitable glue for adhesion as well as the strength of each type of glue, through tensile testing.[1]

Tensile testing is a fundamental test in materials science and engineering. In this test a specimen, in this case two dog-bone specimen halves glued together, is subjected to a controlled tension until failure. Traditionally, this is used as a method to measure ultimate tensile strength, breaking strength, maximum elongation and reduction in area. From these measurements properties such as Young’s modulus, Poisson’s ratio, yield strength, and strain hardening characteristics can be calculated. In these specific experiments the ultimate tensile strength (UTS) for each glue will be calculated, to show which glue is ideal for PLA gluing.

The geometries of the substrate materials are not altered by adhesive bonding, which offer a silent, uniform stress distribution along the bond. They often have favorable damping properties thanks to their polymeric structure, which allows for high fatigue strength of the linkages. However, there are several disadvantages to adhesive bonding that must be considered. Adhesive bonds have limited resistance against peeling stresses and extreme climatic conditions such as temperature and humidity. The latter especially limits the long-term performance of adhesives. In addition, meticulous surface preparation and quality control are required to guarantee a good bond quality[2].

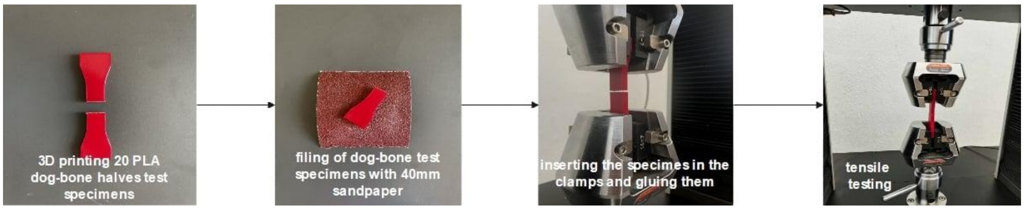

Figure 4 Flow diagram.

The glues used were the following. GlobalExpress Glue Gel Instant Fix Fill Seal In Seconds(A),an instant gel glue which works after the materials glued become exposed to UV flashlight provided. Transparent epoxy glue BORO F-35 (B)consisting of two ingredients (tubes),1 hardener and 1 resin, and starts to harden after 5 minutes. Loctite Super Attak Original (C)is a cyanoacrylate glue and appears as viscous and elastic. Instant glue Super Attak gel Loctite (D)is a gel glue which is extremely viscous and solvent-free. Saratoga Special Adhesive for Plastics, (E) transparent adhesive which starts to harden after 5 mins and is viscous as well.

The method mentioned is independent and not according to ASTM or EN. The PLA specimens were 3D printed, filed and glued. First attempts to glue the specimens before placing them in the machine failed due to rotation leading to breakage. Therefore, specimens were glued on the machine. Specimens were clamped, 3 drops of glue were applied and spread evenly on the bottom half and then the specimens were joined. Each glue was tested at least twice on different specimen halves. Most glues were left to harden for 5 minutes, with exceptions: glue A was left under the UV light provided for 5 minutes, glue B for 10 minutes as per the instructions, and glue E was left for 5 minutes before joining the specimens. A VTS model WDW-10 10kN machine at 2 mm/min was used for the test, applying 350 N of force to glue. The UTS was calculated by dividing the max load with the surface area.

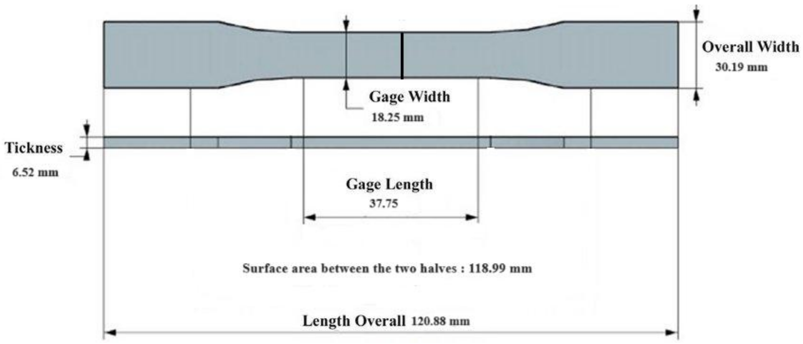

Figure 5 Specimen dimensions[3]

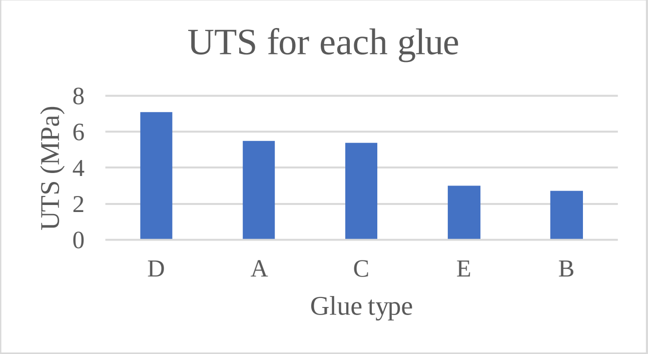

Figure 6 UTS in MPa for each glue type.

According to the results, the glue that can withstand the most amount of stress is D followed by A and C. The E and B glues seem less suitable for PLA although they required more time to solidify completely to reach maximum strength. Moreover, glues A and C were cheaper to purchase so they combine effectiveness with affordability. The best optical result was achieved with the PVC and the gel glues. Finally, each glue was tested 2-4 times but, in most trials, the UTS were close to one another with small divergence.

Acknowledgements: The authors would like to thank Dr. E. Sarafis and V. Prokopiou for their supervision and guidance

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ΣΥΓΚΟΛΛΗΣΗ PLA-ΔΟΚΙΜΕΣ ΕΦΕΛΚΙΣΜΟΥ

Το PLA όντας στο επίκεντρο του ενδιαφέροντος τον τελευταίο καιρό, λόγω της περιβαλλοντικής κρίσης, ως ένα βιοδιασπώμενο και οικονομικό προϊόν βρίσκει εφαρμογή σε ένα πλήθος τομέων. Λόγω της πιθανής αντικατάστασης των συνηθισμένων πλαστικών από το υλικό αυτό θεωρήθηκε ενδιαφέρουσα η διεξαγωγή πειραμάτων με σκοπό την εύρεση της καταλληλότερης κόλλας του εμπορίου για την συγκόλληση του . Για την υλοποίηση των πειραμάτων της παρούσας εργασίας κατασκευάστηκαν δοκίμια από PLA με τρισδιάστατο εκτυπωτή και στην συνέχεια κολλήθηκαν με πέντε διαφορετικές κόλλες για να μετρηθεί η αντοχή της καθεμίας σε δύναμη που ασκείται από μηχανή εφελκυσμού.

e-Poster

ANTIOXIDANT ACTIVITY OF AMPHIPHILIC AND LIPOPHILIC BIOACTIVES OF APPLE PROCESSING BY-PRODUCTS

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Apple pomace (AP) constitutes a by-product of apple processing, with significant environmental footprint and waste management cost. However, AP is a rich source of antioxidant bioactives, such as phenolics and carotenoids, with bioactivities that can scavenge free radicals, offering potential health benefits against oxidative stress and associated disorders. Utilizing AP as a natural rich source of these antioxidants presents an opportunity to valorize a low value bio-waste for the development of novel added value products with health promoting properties, such as functional foods, cosmetics, and pharmaceuticals, aligns with the principles of the circular economy, as established by United Nations [1]. The objective of this study was the analysis of the phenolic and carotenoid content of the lipid nature AP extracts from the a Greek Starkin apple variety cutured in Zagora, Greece, while the evaluation of their antioxidant potency was assessed by specific bioanalytical methods-assays and UV-VIS spectroscopy, as well as qualitative structural analysis for providing a correlation between the structure and the observed antioxidant capacity of these compounds found in AP by Attenuated Total Reflectance (ATR) FTIR spectroscopy.

Solvents of HPLC-grade reagents and other consumables were obtained from Sigma Aldrich (St. Louis, Unites States). The total content in compounds of lipid nature of Apple by-products were extracted using chloroform, methanol, and water solvents and further separated into total lipophilic content (TLC) and total amphiphilic content (TAC) by counter current distribution following Tsoupras et al. [2] methodology. Solvents were removed via flash rotary evaporation, and the resulting extracts were transferred to pre-weighed glass vials. Residual solvents were further evaporated in nitrogen stream, and samples were stored at -20°C for further analysis. Spectrophotometric analysis and absorbance measurements were carried out using a LLG-uniSPEC 2 Spectrophotometer. Total phenolic and carotenoid contents were assessed using Folin–Ciocalteu reagent and UV-VIS spectroscopy, respectively, as previously described in Tsoupras et al. [2]. Antioxidant activity was assessed by both the 2,2-Diphenyl-1-picrylhydrazyl (DPPH) and the 2,2-azinobis-(3-ethylbenzothiazoline-6-sulfonate) (ABTS) assays according Tsoupras et al. with some modifications [2]. Furthermore, the structure of these compounds were analyzed using PerkinElmer Frontier ATR-FTIR according to Vordos et al [3].

Phenolic and carotenoid compounds were found in both TLC and TAC extracts of AP as it is shown in **Figure 1(a,b)**, with TAC showing higher phenolic content compared to that of the TLC extracts. Moreover, the DPPH assay and ABTS assay indicated that both types of extracts possess potent antioxidant activity comparable with that observed in other studies [1-2], with TAC showing more potent antioxidant capacity with statistically significant difference to that of TLC as it is shown in **Figure 1(c,d)**, probably due to the much higher phenolic content observed in TAC extracts. Furthermore, the analysis of the bioactives of the most potent TAC extract of AP, with ATR-FTIR showed similar peaks with carotene equivalent (CE), gallic acid (GAE) and quercetin standards as it is shown in **Figure 2**. GAE and CE act as antioxidants thus, confirming the relationship of structure and antioxidant activity of the AP extract. Overall, the amphiphilc extracts of AP showed promising results as a rich natural source of bioactive antioxidants that can be valorised as functional ingredients in health promoting products against oxidative stress and associated disorders.

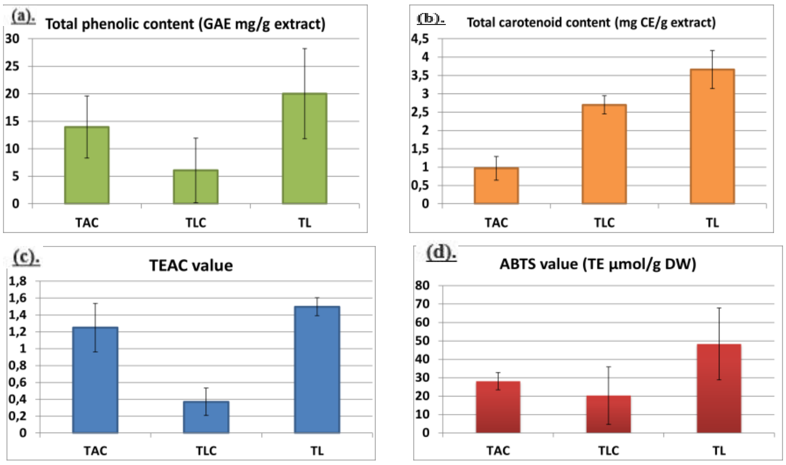

Figure 1. (a). GAE per gr of extract in TAC, TLC and TL (b). CE per gr of extract in TAC, TLC and TL (c). DPPH assay (d). ABTS assay.

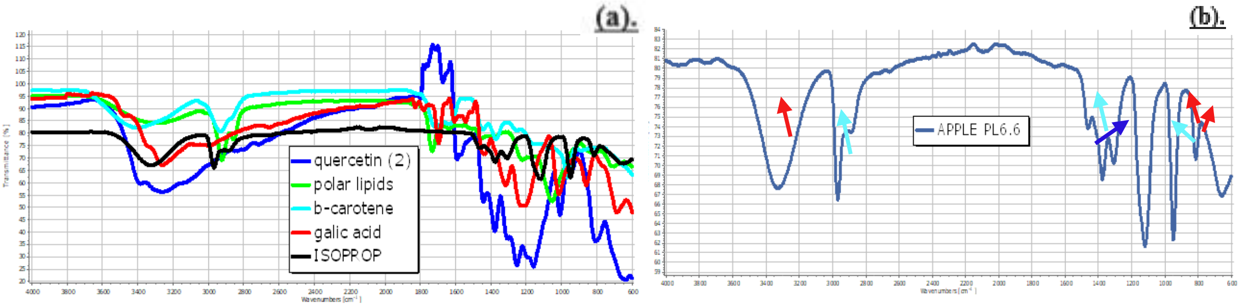

Figure 2. (a). FT-IR spectra of all standard solutions (b). Spectra of apple extract with the arrows indicating the similar peaks to the corresponding standar.

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ΑΝΤΙΟΞΕΙΔΩΤΙΚΗ ΔΡΑΣΗ ΑΜΦΙΦΙΛΩΝ ΚΑΙ ΛΙΠΟΦΙΛΩΝ ΒΙΟΔΡΑΣΤΙΚΩΝ ΑΠΟ ΠΑΡΑΠΡΟΪΟΝΤΑ ΜΗΛΟΥ

Τα παραπροϊόντα του μήλου αποτελούν υπολείμματα της επεξεργασίας τους, με σημαντικό περιβαλλοντικό αποτύπωμα και κόστος διαχείρισης απορριμμάτων. Ωστόσο, τα παραπροϊόντα του μήλου αποτελούν μια πλούσια πηγή αντιοξειδωτικών βιοδραστικών ουσιών, όπως φαινολικά και καροτενοειδή, με βιοδραστηκότητες έναντι των ελεύθερων ριζών, προσφέροντας πιθανά οφέλη για την υγεία κατά του διαταραχών που σχετίζονται με το οξειδωτικό στρες. Ο στόχος της συγκεκριμένης μελέτης ήταν η ανάλυση της περιεκτικότητας σε φαινολικά και καροτενοειδή των εκχυλισμάτων λιποειδικής φύσης από παραπροϊόντα μήλου της ελληνικής ποικιλίας Starkin Ζαγοράς, η αξιολόγηση της αντιοξειδωτικής τους ισχύος με ειδικές βιοαναλυτικές μεθόδους-δοκιμές, καθώς και η ποιοτική δομική ανάλυση με φασματοσκοπία FTIR με εξασθενημένη ολική ανάκλαση (ATR). Τα αποτελέσματα της παρούσης έρευνας έδειξαν ότι τα λιποειδικά εκχυλίσματα παραπροϊόντων μήλου περιέχουν κυρίως αμφίφιλα (φαινολικά), αλλά και λιπόφιλα (καροτενοειδή) βιοδραστικά συστατικά με ισχυρή αντιοξειδωτική δράση, που μπορούν να αξιοποιηθούν ως βιο-λειτουργικά συστατικά καινοτόμων προϊόντων που προάγουν την υγεία έναντι του οξειδωτικού στρες.

e-Poster

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