COMPASS

COMPENDIUM OF RESEARCH PUBLICATIONS 2023

REPUBLIC OF THE PHILIPPINES
DEPARTMENT OF SCIENCE AND TECHNOLOGY
Philippine Nuclear Research Institute

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Department of Science and Technology
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Introduction

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The journal articles and conference presentations are listed alphabetically by title of publication. Each entry has the following components:

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Research Publications

Plant Growth Regulation, 101(1):145-158

AtHDA15 attenuates COP1 via transcriptional quiescence, direct binding, and sub-compartmentalization during photomorphogenesis

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Abstract

Light is an essential environmental cue that determines the overall growth and development of plants. However, the molecular mechanisms underpinning the light signaling network are obscured by the epigenetic machinery where reversible acetylation and deacetylation play crucial roles in modulating light-regulated gene expression. In this paper, we demonstrate that HDA15 represses COP1, the master switch in the light signaling network, by deacetylation, protein interaction, and sub-compartmentalization. *hda15* T-DNA mutant lines exhibited light hyposensitivity with significantly reduced HY5 and PIF3 transcript levels leading to long-hypocotyl phenotypes in the dark while its overexpression exhibited elevated HY5 transcripts and short hypocotyl phenotypes. In vivo and in vitro binding assays further show that HDA15 directly interacts with COP1 inside the nucleus modulating COP1's repressive activities. Crossing *hda15-t*27 with *cop1-4* mutants resulted in short-hypocotyl and dwarfed phenotypes, reminiscent of *cop1-4* mutants suggesting COP1 is epistatic to HDA15. Although light signals the nucleocytoplasmic shuttling of HDA15, the presence of COP1 triggers its nuclear localization. A working model is presented elucidating the concerted interplay between HDA15 and COP1 under light and dark conditions.

Keywords

COP1, HDA15, histone deacetylases, light signal transduction, photomorphogenesis, protein interaction, *Arabidopsis thaliana*

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Cardiovascular testing in the United States during the COVID-19 pandemic: volume recovery and worldwide comparison

Cole B. Hirschfeld, Sharmila Dorbala, Leslee J. Shaw, Todd C. Villines, Andrew D. Choi, Nathan Better, Rodrigo J. Cerci, Ganesan Karthikeyan, João V. Vitola, Michelle C. Williams, Mouaz Al-Mallah, Daniel S. Berman, Adam Bernheim, Robert W. Biederman, Paco E. Bravo, Matthew J. Budoff, Renee P. Bullock-Palmer, Marcus Y. Chen, Michael P. DiLorenzo, Rami Doukky, Maros Ferencik, Jeffrey B. Geske, Fadi G. Hage, Robert C. Hendel, Lynne Koweek, Venkatesh L. Murthy, Jagat Narula, Patricia F. Rodriguez Lozano, Nishant R. Shah, Amee Shah, Prem Soman, Randall C. Thompson, David Wolinsky, Yosef A. Cohen, Eli Malkovskiy, Michael J. Randazzo, Juan Lopez-Mattei, Purvi Parwani, Mrinali Shetty, Thomas N. B. Pascual, Yaroslav Pynda, Maurizio Dondi, Diana Paez, Andrew J. Einstein – on behalf of the INCAPS COVID 2 Investigation Group

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Abstract

Purpose: To characterize the recovery of diagnostic cardiovascular procedure volumes in U.S. and non-U.S. facilities in the year following the initial COVID-19 outbreak.

Materials and Methods: The International Atomic Energy Agency (IAEA) coordinated a worldwide study called the IAEA Noninvasive Cardiology Protocols Study of COVID-19 2 (INCAPS COVID 2), collecting data from 669 facilities in 107 countries, including 93 facilities in 34 U.S. states, to determine the impact of the pandemic on diagnostic cardiovascular procedure volumes. Participants reported volumes for each diagnostic imaging modality used at their facility for March 2019 (baseline), April 2020, and April 2021. This secondary analysis of INCAPS COVID 2 evaluated differences in changes in procedure volume between U.S. and non-U.S. facilities and among U.S. regions. Factors associated with return to prepandemic volumes in the United States were also analyzed in a multivariable regression analysis.

Results: Reduction in procedure volumes in April 2020 compared with baseline was similar for U.S. and non-U.S. facilities (−66% vs −71%, P = .27). U.S. facilities reported greater return to baseline in April 2021 than did all non-U.S. facilities (4% vs −6%, P = .008), but there was no evidence of a difference when comparing U.S. facilities with non-U.S. high-income country (NUHIC) facilities (4% vs 0%, P = .18). U.S. regional differences in return to baseline were observed between the Midwest (11%),

Northeast (9%), South (1%), and West (−7%, *P* = .03), but no studied factors were significant predictors of 2021 change from prepandemic baseline.
Conclusion: The reductions in cardiac testing during the early pandemic have recovered within a year to prepandemic baselines in the United States and NUHICs, while procedure volumes remain depressed in lower-income countries.

Keywords
SPECT, cardiac, epidemiology, angiography, CT angiography, CT, echocardiography, SPECT/CT, MR imaging, radionuclide studies, COVID-19, cardiovascular imaging, diagnostic cardiovascular procedure, cardiovascular disease, cardiac testing

Philippine Journal of Science, 152(1):397-400

Comparative study on determination of critical minerals in Ni laterites using handheld LIBS, handheld XRF, and ICP-MS

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Abstract

Critical minerals (CMs) such as nickel (Ni), cobalt (Co), chromium (Cr), manganese (Mn), and zinc (Zn) are materials essential to the economy, but the supply is vulnerable to disruption. Ni laterite deposits are considered potential sources of these CMs. In this study, the Ni, Co, Cr, Mn, and Zn contents of 15 Ni laterite samples from Zambales and Surigao were determined using handheld laser-induced breakdown spectroscopy (hLIBS) and handheld X-ray fluorescence (hXRF) analyzers. The samples were also analyzed using inductively coupled plasma mass spectrometry (ICP-MS) to compare the handheld analyzers with the established laboratory technique. The two-sided t-tests show no significant differences between the average Ni, Cr, Mn, and Zn results of hLIBS and hXRF with respect to ICP-MS. The average hXRF result of Co significantly differs from ICP-MS, whereas hLIBS has no significant difference from ICPMS. Therefore, hLIBS and hXRF can be used to determine the Ni, Cr, Mn, and Zn contents in laterites, whereas hLIBS can be utilized to determine the Co values of laterites. Both hLIBS and hXRF analyzers can be for CM exploration of Ni laterite deposits.

Keywords

cobalt, critical minerals, ICP-MS, LIBS, Ni laterite, XRF

Analytical Letters, 56(6):932-943

Determination of scandium (Sc), yttrium (Y), and rare-earth elements (REEs) in mafic and ultramafic rock powder by a modified and validated digestion protocol and inductively coupled plasma – mass spectrometry (ICP-MS)

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Abstract

The global demand for rare earth elements (REEs) has been associated with the increased use of renewable energy technologies. However, due to the low occurrence of REEs in economic sources, such as geologic samples, it is essential to employ suitable sample preparation methods and measurement techniques that allow for reliable quantification. While acid digestion procedures have been conventionally used to free metals from silicate rocks, few studies have evaluated these methods for quantitative measurement of REEs, including Sc and Y in mafic-ultramafic rocks. This study involves validating a modified digestion procedure to facilitate the determination of Sc, Y, and REEs in mafic-ultramafic matrices. Three reference materials (RMs) (OKUM, BHVO-1, and JB-1a) were used to assess the performance of this modified method. The calculated percent error (< 10%) for most elements was in good agreement with the reference values, except La in OKUM, Er in BHVO-I, and Eu, Gd, Tb, Ho, and Er in JB-1a. The precision of the modified method was satisfactory, with values generally below 5%. The smooth chondrite normalized REE patterns indicate good quality data. The t-values of the studied elements were lower than the t-critical value (± 12.71), suggesting no significant differences between the analytical and Intertek values. Thus, the modified method could be used as a viable alternative in determining REEs in Ni laterite samples by ICP-MS.

Keywords

inductively coupled plasma – mass spectrometry (ICP-MS), mafic-ultramafic rock, rare earth elements (REEs), scandium (Sc), yttrium (Y)

Radiation Protection Dosimetry, 199(18):2244-2247

Development of calculation tool for iodine 131 biodistribution depending on the aerosol particle distribution

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Abstract

Radiation damage to tissues depends on radiation exposure levels. Therefore, we have studied accurate estimations of radiation exposure levels so far. Recently, we developed a tool that can calculate the respiratory tract deposition of radionuclides based on polydisperse particle size distribution. As a next step, there is a need for a new calculation tool for the biodistribution of radionuclides because a fraction of the radionuclides deposited in the respiratory tract is absorbed into the body. In this study, a calculation tool for iodine 131 biodistribution depending on aerosol size distribution was developed. The developed tool in this study is used with the former tool.

Eco-friendly dye adsorbent from poly(vinyl amine) grafted onto bacterial cellulose sheet by using gamma radiation-induced simultaneous grafting and base hydrolysis

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Abstract

N-vinylformamide (NVF) was successfully grafted onto a bacterial cellulose (BC) sheet through gamma radiation-induced simultaneous grafting. The optimum conditions for grafting were an irradiation dose of 15 kGy and an NVF concentration of 30% vol. The resulting product, poly(vinyl formamide)-grafted-bacterial cellulose sheet (PNVF-g-BC) was hydrolyzed using a basic medium to obtain poly(vinyl amine)-grafted-BC (PVAm-g-BC) as an eco-friendly dye adsorbent. The maximum degrees of NVF grafting and hydrolysis were 98.89 ± 3.95% and 88 ± 0.55%, respectively. Chemical, binding energy, crystalline, thermal, and morphological characterizations of the starting materials, as well as PNVF-g-BC and PVAm-g-BC adsorbents, were conducted. Batch tests were performed to investigate the efficiency of methylene blue (MB) adsorption and the adsorption capacity of the PVAm-g-BC adsorbent. The effects of initial MB concentration, time, and pH on the adsorption were studied. The maximum adsorption capacity of the adsorbent was 7.78 ± 0.41 mg/g at an MB concentration of 10 mg/L, pH 13, and a reaction time of 8 h. The adsorption behavior of MB onto the adsorbent was found to fit the Langmuir isotherm model, indicating monolayer adsorption. The adsorption/desorption study demonstrated that the adsorbents could be reused for 6 cycles with effective performance for MB adsorption (> 50%). This eco-friendly dye adsorbent exhibits outstanding properties as a potential candidate for dye adsorption.

Keyword

bacterial cellulose, radiation-induced grafting, dye adsorption

Heliyon, 9(5):e15713

Ecological and health risks from heavy metal sources surrounding an abandoned mercury mine in the island paradise of Palawan, Philippines

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Abstract

A recent survey that determined heavy metal concentrations in an abandoned Hg mine in Palawan, Philippines, found the occurrence of Hg with As, Ba, Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb, Sb, Tl, V, and Zn. While the Hg originated from the mine waste calcines, the critical knowledge about the origin of the other heavy metals remains unknown. This study assessed the ecological and health risks from heavy metal pollution surrounding the abandoned Hg mine. Principal component analysis (PCA) showed that the abandoned mine and natural sources (i.e., local geology) are the two main contributors of heavy metal pollution. Historically, the mine waste calcines (retorted ore) were used as construction material for the wharf and as land filler for the adjacent communities. There is highly strong ecological risk associated with the heavy metals: Ni, Hg, Cr, and Mn contribute 44.3%, 29.5%, 10.7%, and 8.9% to the potential ecological risk index (RI), respectively. Hazard index (HI) exceeded 1 for both adults and children in all the sampling locations, implying non-carcinogenic adverse effects. The total cancer risk over a lifetime (LCR) also exceeded the threshold limit of 10^{-4} for both adults and children, contributed mainly by Cr (91.8%) and As (8.1%). By combining the results of the PCA and risk assessments, a clear link between heavy metal source apportionment to ecological and health risks was established. It was estimated that the abandoned mine contributed to most of the ecological and health risks for people living near the wharf that was built using the calcine, as well as the nearby Honda Bay. The findings of this study are expected to help policy makers develop regulations that will safeguard the ecosystem and the general public from the damaging impacts of heavy metals from the abandoned mine.

Keywords

abandoned mine, heavy metals, multivariate analysis, public health and ecological risk assessments, sediment and soil pollution

Results in Optics, 12:100491

Effect of ZnO nanoparticles on physical, optical and radiation shielding properties of Bi_2O_3-B_2O_3-Cr_2O_3 glasses

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Abstract

With a composition (in mol %) of $29Bi_2O_3$-$70B_2O_3$-$(1-x)Cr_2O_3$: xZnO, (where, x = 0, 0.5 and 1) three glass samples were prepared by melt-quenching process. Despite the addition of ZnO nanoparticles, the SEMmorphology studies showed that the synthesized samples were transparent glass-ceramics. XRD studies confirmed that ZnO nanoparticles were homogeneously distributed in the glassy phase. When ZnO nanoparticles were added, oxygen packing density (OPD) was observed to increase, whereas boron-boron separation (d_{B-B}) gradually decreased. The Raman spectra demonstrated that there was transformation of primary glass forming units, $[BO_3] \rightarrow [BO_4]$ units from x = 0 to 1 mol% of ZnO nanoparticles in the composition. Two absorption bands (in blue and red regions) have been attributed to the d-d transitions of Cr^{3+} ions in octahedral symmetry sites. When ZnO nanoparticles were added in the composition, the bandgap (E^o) was found to increase, and the nonlinear optical susceptibility ($\chi^{(3)}$) decreased. Various gamma ray shielding properties of the samples have been determined in the energy range of 1 keV–15 MeV with the help of the Windows based program EpiXS. The sample with highest concentration of ZnO nanoparticles in the composition showed better radiation shielding behaviour among the three samples.

Keywords

bismuth-borate glasses, zinc oxide nanoparticles, Raman spectroscopy, optical susceptibility, attenuation coefficients, buildup factors

Elemental distribution and source analysis of atmospheric aerosols from Meycauayan, Bulacan, Philippines

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Abstract

One of the industrialized cities in the Philippines is Meycauayan, Bulacan. This study reports the elemental distribution and source apportionment in eight varying land cover-land use type sampling points located along the Marilao-Meycauayan- Obando Rivers System. Elemental analysis was conducted using a scanning electron microscope coupled with energy dispersive xray. Cu, Pb, Zn, Cr, Mn, As, Cd, Co, Fe, Ni, Ti, and V concentrations were determined using Inductively Coupled Plasma Mass Spectrometry, and Hg concentrations by Mercury analyzer. Principal component analysis (PCA), hierarchical cluster analysis (HCA), and Pearson's r correlation were used to analyze different sources of heavy metals and its corresponding land use-land cover type. The aerosol samples showed the presence of heavy metals Pb and Hg, elements that were also detected in trace amounts in the water measurements. Concentrations of heavy metals such as Cu, Fe, Pb, Zn, V, Ni, and As found in the atmospheric aerosols and urban dusts were attributed to anthropogenic sources such as residential, commercial and industrial wastes. Other source of aerosols in the area were traffic and crustal emissions in Meycauayan. Using HCA, there are 3 clusters observed based on the similar sets of heavy metals: (1) AQS1 (Caingin), AQS2 (Banga), and AQS8 (Malhacan); (2) AQS3 (Calvario), AQS4 (Camalig), and AQS5 (Langka); (3) AQS1 (Sto Nino-Perez), and (AQS7) (Sterling). These groups are related based on different land use setting such as residential/commercial, agricultural, and commercial/industrial areas. Our study recommends the need to address heavy metal pollution in Meycauayan in support to the ongoing implementation of laws and regulations by the local and private sectors.

Keywords

Meycauayan, heavy metal assessment, atmospheric aerosols, urban dusts, land use

Radiation Physics and Chemistry, 206:110770

ENDF/B-VIII.0-based fast neutron removal cross sections database in Z = 1 to 92 generated via multi-layered spherical geometry

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Abstract

A fast neutron mass removal cross sections (Σ_R/ρ) database covering the elemental range of Z = 1 to 92 is generated for source neutron energy distributions based on ^{241}Am–Be, ^{252}Cf, and ^{235}U. Monte Carlo simulations using ENDF/B-VIII.0 nuclear data were performed with the fast neutron removal theory's ideal spherical representation. The ENDF/B-VIII.0-based Σ_R/ρ's derived were compared with values from the Oak Ridge National Laboratory's Lid Tank Shielding Facility (LTSF) experiments, values from software Phy-X/PSD and MRCsC, values obtained by an empirical model in Zoller, and values derived using the older ENDF/B-VII.0 nuclear data library. Subsequently, the generated Σ_R/ρ's were evaluated for convergence under varying moderator thickness. Results indicate that the Σ_R/ρ quantity for fission and (alpha, n) spectra is universal, with slight deviations for low Z elements. The Σ_R/ρ values generated from ENDF/B-VIII.0 agreed with LTSF experiments with an average relative deviation of 8.58%. Moreover, using ENDF/B-VIII.0-based Σ_R/ρ's, the derived fast neutron effective removal cross sections (Σ_R's) for several light compounds and dry concrete have better agreement on average with LTSF experiments compared with values derived from the available Σ_R/ρ's in the literature. Significant differences were found for Σ_R/ρ's that were generated with ENDF/B-VIII.0 as compared with the superseded ENDF/B-VII.0. Furthermore, ENDF/B-generated Σ_R/ρ's through spherical model showed the expected convergence towards singular values at moderator thicknesses practical for fast neutron removal theory applications. Owing to the relatively high unavoidable uncertainties of the LTSF experimental Σ_R/ρ 's, the ENDF/B-VIII.0-based Σ_R/ρ 's present a new and potentially favorable database in Σ_R general calculations for homogeneous multielement materials for point-kernel shielding applications.

Keywords

elastic scattering, inelastic scattering, macroscopic removal cross section, mass removal cross section, neutron shielding

Philippine Journal of Science, 152(3):871-880

Evaluation of blood-feeding methods for rearing dengue mosquito, *Aedes aegypti* L. (Diptera: Culicidae)

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Abstract

Maintaining a mosquito colony for rearing is essential in research, and the rearing of mosquitoes in the laboratory requires blood as a protein source for females to produce eggs. The use of live animals for blood-feeding imposes ethical considerations and entails an additional laboratory for rearing the live animals. In this study, we have established an artificial blood-feeding system for *Aedes aegypti* that took into consideration the effects of four factors on blood-feeding – namely, egg source colony, blood source, age of females, and heating intervals. For the quality control tests, all parameters tested did not significantly differ between colonies after 14 generations. In terms of egg source, more adult females significantly fed from pig blood (PB) colonies (78%) than live mice (LM) colonies. In terms of blood source, more adult females (85%) fed on immobilized LM than in the artificial blood-feeding system with PB as a blood source. In terms of age, 3- and 5-d-old females showed the highest % blood-feeding (75–78%), fecundity, fertility, and recoveries compared to when females were fed very young at 1 d old and quite old at 7 d old. Among the heating intervals tested, re-heating PB every 60 min for 4 h showed the highest % of females fed (66%). All four factors significantly explain the variation in the % blood-feeding efficiency of female mosquitoes and, therefore, important factors to consider in mosquito colony maintenance. We also conclude that the established artificial blood-feeding system can be used for rearing *Ae. aegypti*. The results of the study may encourage laboratories in other institutes that conduct mosquito colony maintenance to seek inexpensive, effective, and locally-available artificial blood-feeding systems.

Keywords

artificial feeder, blood-sucking, feeding efficiency, feeding membrane, sterile insect technique

International Journal of Nano Dimension, 14(3):212-218

Fused nanogranular polyaniline-sawdust (*Cocos nucifera*) composite for lead adsorption application

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Abstract

The problem of heavy metal contamination in industrial effluents requires new and environment-friendly agents for wastewater treatment. In this study, we developed fused nanogranular polyaniline-sawdust (PANI/SD) composites for lead ion removal through the adsorption process. To prevent the aggregation of polyaniline (PANI), coconut (*Cocos nucifera*) sawdust (SD), an agricultural waste, was used as a substrate via *in situ* chemical polymerization in varied sawdust-to-aniline ratios. The scanning electron micrographs (SEM) of the obtained PANI/SD composites revealed a nanogranular structure that indicated the complete coating of polyaniline on sawdust. Furthermore, the PANI/SD composites were verified to be in the emeraldine oxidation state through Fourier-Transform Infrared (FT-IR) spectroscopy. Among the formulations studied, the PANI/SD composite with a sawdust-to-aniline ratio of 1.2 g/mL was found to have the highest adsorption capacity of 738.9 mg/g. This study presents the promising potential of PANI/SD as a novel and cost-effective adsorbent material to remove lead from contaminated water.

Keywords

adsorption, lead, polyaniline, sawdust, wastewater

Soil and Sediment Contamination: An International Journal, 32(8):1033-1052

Heavy metal pollution in soil and surface sediments of Meycauayan River, Philippines and their relationship to environmental indicators

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Abstract

The City of Meycauayan is an industrial powerhouse in the Philippines. It is considered as one of the most polluted cities in the developing world on the account of industrial discharges of toxic materials to the environment. This work investigated the sources of the heavy metal pollution in Meycauayan by analyzing soil and sediment samples for heavy metals like Chromium (Cr), Mercury (Hg), Nickel (Ni), and Lead (Pb) together with selected environmental indicators such as Total Nitrogen (TN), Total Organic Matter (TOM), and Total Phosphorus (TP) located along the Meycauayan River. Hierarchical cluster analysis (HCA), principal components analysis (PCA), and Pearson correlation analysis (CA) were used to identify the sources of the metals. Our results show delineated locations of severe levels of heavy metal pollution downstream of the river because of the concentration of industrial activities. Cr is due to proliferation of tanneries discharging untreated wastewaters to the river. Significant input of Pb and Hg from Pb-acid battery recycling and gold smelting industries were also found. The risk assessments also indicate severe levels of heavy metal pollution in locations where industrial activities are concentrated. Our findings indicate that the heavy metals have similar impacts to K, TN, TOM, and TP in the soil and sediments. Our study shows the serious need to address heavy metal pollution in Meycauayan aside from the ongoing cleanup of solid wastes as part of rehabilitation efforts by the local government.

Keywords

heavy metals, sediments, Meycauayan River, soil pollution, sediment quality guidelines, environmental indicators

Science of Total Environment, 887:164021

^{129}I in the SE-Dome ice core, Greenland: a new candidate golden spike for the Anthropocene

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Abstract

The Anthropocene is a proposed geological epoch that will mark the time when humans have irreversibly affected the Earth. One of the primary requirements to formally establish this is a Global Boundary Stratotype Section and Point or “golden spike” – a record of a planetary signal marking the new epoch's beginning. The leading candidates for the Anthropocene's golden spike are the fallout peaks of ^{14}C ($T_{1/2}$ = 5730 y) and ^{239}Pu ($T_{1/2}$ = 24,110 y) from nuclear weapons testing in the 1960s. However, these radionuclides' half-lives may not be long enough for their signals to be observable in the far future and are, thus, not durable. In this regard, here we show the ^{129}I time series record (1957–2007) of the SE-Dome ice core, Greenland. We find that ^{129}I in SE-Dome records almost the entire history of the nuclear age in excellent detail at a time resolution of about four months. More specifically, ^{129}I in SE-Dome reflects signals from nuclear weapons testing in 1958, 1961, and 1962, the Chernobyl Accident in 1986, and various signals from nuclear fuel reprocessing within the same year or a year after. The quantitative relationships between ^{129}I in SE-Dome and these human nuclear activities were established using a numerical model. Similar signals are observed in other records from various environments worldwide, such as sediments, tree rings, and corals. This global ubiquity and synchronicity are comparable to those of the ^{14}C and ^{239}Pu bomb signals, but the much longer half-life of ^{129}I ($T_{1/2}$ = 15.7 My) makes it a more durable golden spike. For these reasons, the ^{129}I record of the SE-Dome ice core can be considered an excellent candidate for the Anthropocene golden spike.

Keywords

GSSP, iodine-129, nuclear weapons testing, global fallout, bomb peak, natural archives, accelerator mass spectrometry

Method validation for the in-house developed procedure for liquid scintillation spectroscopy for the determination of gross alpha and gross beta activities in water

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Abstract

The Philippine National Standards for Drinking Water (PNSDW) includes the determination of the radiological quality of drinking water to ensure that water is safe from contamination due to fallout, or suspected sources of radiological impurities such as hospitals and industries. The standards require testing for gross alpha and gross beta (excluding radon) as an initial screening technique to assess the radiological quality of water. The standard limits are: 0.1 Bq/L for gross alpha and 1.0 Bq/L for gross beta. A liquid scintillation (LSA) based method that requires smaller sample quantities, less sample preparation time and operator intervention, and produces adequate minimum detection levels for local drinking water guidelines has been developed which uses Tri-Carb 3170 TR/SL and Wallac 1414 counting systems, and has been found to be adequate and sensitive for the simultaneous determination of alpha and beta counts. Detection limits of ≤0.05 Bq/L for gross alpha and ≤0.3 Bq/L for gross beta were achieved for a total of two hours counting per sample. The method was accredited under ISO/IEC 17025 by the Philippine Accreditation Office in 2009. A new liquid scintillation counting system (Tri-Carb 3180 TR/SL) has been acquired. This system has been marked AMR-LSC-03. The use of the new counter requires method validation before use, to verify that the same results, as those generated using the Tri-Carb 3170 TR/SL (AMR_LSC_02) are obtained using Tri-Carb 3180 TR/SL (AMR-LSC-03). The method developed was validated by comparing the results obtained for alpha counts using Am 241 standard and beta using Cl 36 standard. Results generated by the Tri-Carb 3 180 TR/SL (AMR-LSC-03) were generally acceptable. Detection limits of ≤0.05 Bq/L for gross alpha and ≤0.3 Bg/L for gross beta were achieved using the Tri-Carb 3 180 TR/SL (AMR-LSC-03) for a total of four hours counting per sample.

Keywords

drinking water radiological quality, Liquid Scintillation Spectrometry, gross alpha activity, gross beta activity, radiological impurities, liquid scintillation counting systems

Radiation Physics and Chemistry, 208:110916

Microstructural characterizations and radiation shielding quantities of rice husk ash-based self-compacting concrete and its precursors

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Abstract

This paper investigates the microstructural, chemical, and radiation shielding characteristics of rice husk ashbased self-compacting concrete (RHA-SCC) and its precursors – rice husk ash (RHA) and ordinary Portland cement (OPC). Several radiation attenuation parameters of RHA-SCC, RHA, and OPC have been studied using EpiXS. Characterizations of these samples using FTIR, XRD, and SEM were also employed for chemical bonds, mineral phase, and morphological analysis, respectively. The XCOM data library was utilized to obtain mass attenuation coefficients (MAC) and related to EPICS2017 and EPDL97 data. From the results, prominent interaction mechanisms for RHA-SCC were photoelectric absorption, incoherent scattering, and pair production in the nuclear field. Both the mean free path (MFP) and half-value layer (HVL) values agreed to this sequence: OPC > RHA > RHA-SCC. The Z_{eff} values recorded for high-photon energies were 13.95, 13.20, and 10.85 for RHA-SCC, RHA, and OPC, respectively. While maximum N_{eff} was estimated at the low-energy region with values of 4.68, 4.70, and 3.89 electrons·g^{-1} for RHA-SCC, RHA, and OPC. Both buildup factors were highly affected by the presence of higher Z elements contained in RHA-SCC, reaching up to 200 keV at 40 MFP. For intermediate and higher-energy levels, the MAC values established this order: RHA-SCC > OPC > RHA, with the lowest deviation of 0–0.21% for EPICS2017-EPDL97 tandem. Overall, RHA-SCC has better shielding effects compared to its precursors and can cost-effectively be used as an additive in preparing radiation shielding concrete.

Keywords

electrons, EpiXS, microstructural characterization, radiation shielding, rice husk ash

Molecular Biology Research Communications, 12(2):71-76

Molecular mimicry and COVID-19: potential implications for global fertility

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Abstract

There has been a concerning increase in the incidence of autoimmune diseases following SARS-CoV-2 infection, with molecular mimicry proposed as a potential mechanism. Our study identified nine fertility-associated proteins (AMH, BMP2, CUBN, DNER, ERCC1, KASH5, MSLN, TPO, and ZP3) that exhibit potential molecular mimicry with MHC-II epitopes of SARS-CoV-2 proteins (N, ORF1A, ORF1AB, and S). We screened for epitopes based on in silico binding using DR-, DQ-, and DP-haplotypes that predispose susceptible individuals to autoimmune diseases. Our systematic analysis revealed that 41 countries with population coverage of over 50% had a pre-COVID pandemic total fertility rate of less than 2.1 births per woman. With over 761 million people from 229 countries and territories infected since December 2019, there may be a potential for a foreseeable negative effect on fertility in specific countries, particularly in high-income economies experiencing rapid demographic changes.

Keywords

SARS-CoV-2, autoimmune diseases, molecular mimicry, fertility, MHC-II epitopes, in silico binding

Native metallophytes on ultramafic wooded grassland in Sta Cruz, Mindoro Occidental, Philippines: insights into phytostabilization and forest restoration

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Abstract

The native metallophytes species are the optimum choice to restore degraded areas on ultramafic soil. However, a limited restorative floristic survey on the wooded grassland of Mindoro Occidental had been reported. Four 20 m x 20 m plots were established to rapidly assess the plant diversity of a wooded grassland on ultramafic soil in Sta. Cruz, Mindoro Occidental, Philippines. Diversity index (H`), relative density, relative dominance, and importance value (IV) were computed. Physicochemical characteristics and heavy metal contents of the soil in the site were analytically determined. We identified 43 morphospecies of plants belonging to 25 families. Thirty-six of the morpho-species identified are Philippine natives and typically grow on ultramafic forests. Nine species out of the top 10 trees with the highest IV are native ones, with *Buchanania arborescens* Blume as the most dominant. The estimate of Relative Cover (%) also showed native species. Poles and sapling dominated the area, suggesting that active regeneration is taking place. Further, 72.94% of the ground cover were represented by tree flora recruits (e.g., *B. arborescens*, *Alstonia macrophylla*). The sites have overall moderate diversity (H` index of 2.7). The soil contains a high amount of Nickel, Chromium, Iron, and Manganese. There were no Nickel hyperaccumulators but 22 native species showed Aluminum and Silicon hyperaccumulation. Therefore, the study revealed that the surveyed area is home to important metallophytes that have the potential for phytostabilization and reforestation.

Keywords

acid soils, aluminum hyperaccumulators, metallophytes, rapid assessment, serpentine

Journal of Cleaner Production, 414:137561

Phosphogypsum circular economy considerations: a critical review from more than 65 storage sites worldwide

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Abstract

Nearly 300 million t of phosphogypsum (PG) are produced every year as a byproduct from phosphate fertilizer production worldwide. Approximately 58% of the PG are stacked, 28% are discharged in coastal waters and only 14% are further processed. This critical review provides an overview of the physical-chemical properties of PG produced from sedimentary and magmatic phosphate ore worldwide using various analytical tools. Results from more than 25 years of work on PG at École des Mines de Saint-Étienne are presented and critically discussed. In total PG samples from 67 industrial storage sites around the world and PG samples synthesized under different conditions in the laboratory have been considered. The low radioactivity present in PG (particularly PG produced from sedimentary phosphate rock) was identified as the main challenge to using PG as a raw material in construction. Water-soluble and volatile chemical compounds were identified as the main challenge to environmentally sound PG management. Although PG does (in most cases) not pose an immediate threat to the environment the authors recommend processing all PG instead of storing or disposing it, to eliminate potential long-term risks and utilize a relevant secondary resource.

Keywords

phosphogypsum, circular economy, radioactivity, cleaner production

Clay Minerals, 58(3):258-266

Photon shielding properties of alkali- and acid-treated Philippine natural zeolite

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Abstract

The effects of chemical treatment on the radiation-shielding properties of Philippine natural zeolites were investigated using *EpiXS* following the EPICS2017 library. The zeolites were studied using X-ray diffraction and energy-dispersive X-ray spectroscopy. The acid treatment eliminated Fe and Ca, having a negative impact on the cross-section of the HCl-modified zeolite. The mass attenuation coefficients of the raw, NaOH- and HCl-modified zeolites at 1332 keV were 0.0545, 0.0544 and 0.0548 $cm^2\ g^{-1}$, respectively. At 100–10,000 keV, the linear attenuation coefficient depends on the density and increases in the order HCl-modified > NaOH-modified > raw zeolite. In the energy range of 100–16,000 keV, the mean free path and half-value layer values are in the order of HCl-modified < NaOH-modified < raw zeolite. The raw and NaOH-modified zeolites have comparable effective atomic numbers, whereas the HCl-treated zeolite has significantly lower such values.

Keyword

EPICS2017, *EpiXS*, gamma-rays, natural zeolite, photon attenuation

Marine Pollution Bulletin, 192:115032

Pollution assessment of mercury and other potentially toxic elements in the marine sediments of Mambulao Bay, Jose Panganiban, Camarines Norte, Philippines

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Abstract

In Jose Panganiban, Camarines Norte, small-scale gold miners dispose of untreated tailings into nearby rivers, which eventually flow into Mambulao Bay. In this study, nine (9) marine sediments were collected and analyzed to assess the pollution of potentially toxic elements (PTEs) in Mambulao Bay. Au concentrations in the sediments were also determined. The results showed that the Mambulao Bay sediments have high concentrations of Hg and other PTEs. The average concentrations of potentially toxic elements in the marine sediments were observed in the following order: Zn (638 mg/kg) > Pb (297 mg/kg) > Cr (283 mg/kg) > Cu (209 mg/kg) > Ni (146 mg/kg) > As (35 mg/kg) > Hg (4.4 mg/kg) > Cd (1.4 mg/kg). Geoaccumulation index values suggest that Mambulao Bay sediments close to the Danao River estuary are strongly to extremely polluted by Hg, strongly polluted by Pb, moderately to strongly polluted by Zn, and moderately polluted by Cd, Cu, Cr, Ni, and As. A high average Au concentration (0.42 mg/kg) was also reported in the sediments. The enrichment values suggest that the PTE pollution has an anthropogenic origin, most likely from the artisanal gold mine tailings of Jose Panganiban. Most of the marine sediments have Hg, Pb, Zn, and Cu concentrations above the probable effect levels for PTEs, which can result in occasional adverse biological effects on the aquatic biota of Mambulao Bay. The average Hg content of Mambulao Bay sediments is higher than those of Honda and Agusan Bays, while the average Pb and Zn contents are higher than those of Honda and Butuan Bays, Boac River estuary, and Tañon Strait. These results can help the government address marine pollution in Mambulao Bay for sustainable aquatic resources and coastal management and can serve as a baseline for future monitoring and assessment of the water body.

Keywords

potentially toxic element, mercury, marine sediment, pollution assessment, small-scale gold mine, Camarines Norte

Arabian Journal for Science and Engineering (Special Issue: Challenges and Recent Advancements In Nuclear Energy Systems)

The potential application of mining wastes and slag as radiation shielding: a characterization study using EpiXS

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Abstract

The inclusion of nuclear energy in the Philippines' energy mix raises the prospect of the country developing a nuclear power program. More than ever, there is a need for a radioactive waste management system that includes a mechanism for disposing of radiation waste. In this study, Philippine mine wastes and mining byproducts (i.e., ferronickel slag, nickel mine waste, gold-mine tailings, and copper-mine tailings) are characterized for radiation shielding properties using the EPICS2017 library and interpolated by the EpiXS software for potential use as low-level radioactive waste (LLW) embankment. The mass attenuation coefficients (*MAC*) in the intermediate to high gamma energy range of 662–1332 keV were as follows: gold-mine tailings > ferronickel slag > copper-mine tailings > nickel mine wastes. Nickel mine wastes, when compared to other mining wastes, has the highest effective atomic number (Z_{eff}) and the highest effective electron density (N_{eff}), except for photon energies between 4 and 8 keV. The photoelectric predominance region has the lowest exposure buildup factors (*EBF*) and the Compton scattering predominance region has the greatest *EBF*. The *MACs* of ferronickel slag, gold- and copper-mine tailings are greater than some waste-based mortar and heavyweight concrete and comparable to slag- and fly ash-based geopolymers at intermediate to high gamma energies. Among the mine wastes taken into consideration, nickel wastes would typically be the best embankment material for LLW in terms of attenuating X-rays and gamma rays. It is comparable to Portland cement's radiation-shielding properties.

Keywords

embankment, EpiXS, gamma-rays, mine waste, photon shielding

Arabian Journal for Science and Engineering, 48(1):1021-1029

Radiation shielding properties of ZnO and other glass modifier oxides: BaO, MgO, Na_2O, and TiO_2, using EpiXS Software

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Abstract

The study investigates the photon shielding characteristics of ZnO and other glass modifier oxides such as BaO, MgO, Na_2O, and TiO_2 as a viable additive for anti-radiation glass systems using the EPICS2017 library interpolated by EpiXS software. Their total cross sections and the linear attenuation coefficients are large at low energies but become smaller as photon energy increases. The computed mass attenuation coefficients of ZnO at gamma-ray energies of 356, 662, 1173, and 1332 keV are 0.1017, 0.0739, 0.0554, and 0.0519, respectively. The mean free path of ZnO is longer than that of BaO, but shorter than that of MgO, Na_2O, and TiO_2. The glass modifiers' half-value and tenth-value layers are in the sequence BaO < ZnO < TiO_2 < MgO < Na_2O. For energies of 60, 364, 662, and 1332 keV, the HVL values of ZnO, or the thickness required to reduce the intensity of the incident photon by half, are 0.083, 1.23, 1.67, and 2.38 cm, respectively. Depending on the penetration depth, the highest values for both energy absorption (EABF) and exposure buildup factors were observed in the 400–500 keV energy range. ZnO has the lowest EABF for X-ray energy and the second lowest for 101–120 keV gamma energy. The Z_{eff} of the five oxides at X-ray energy is substantially higher than their Z_{eff} at gamma energy. ZnO is only second to BaO in terms of radiation shielding efficiency, making it a better additive material for various anti-radiation glass systems.

Keywords

EpiXS, glass modifiers, photon attenuation, radiation shielding, ZnO

Radiocarbon assay technique for the detection of non-biogenic acetic acid in Philippine vinegar

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Abstract

Vinegar, an integral component of Filipino cuisine for ages, has become susceptible to falsification with the incorporation of non-biogenic acetic acid, owing to its popularity. A fresh technique employing radiocarbon analysis has been devised to identify the presence of non-biogenic acetic acid within vinegar. This novel approach was cross validated against the established Permanganate Oxidation Number (PON) method, recognized by AOAC as the standard means of distinguishing between vinegar derived from natural processes and non-biogenic sources. By establishing standard C-14 activity benchmarks for biogenic vinegar in the Philippines through the innovative radiocarbon analysis, C-14 activity levels exceeding 12 disintegrations per minute per gram of Carbon (dpm/g C) were determined. The outcomes underscored that among 65 vinegar samples collected from prominent cities and provinces across the country, 32 contained synthetic or non-biogenic acetic acid with C-14 activity values falling below 12 dpm/g C. This research validates the efficacy and feasibility of utilizing radiocarbon analysis as a dependable method for discriminating between non-biogenic and fermentative acetic acid in vinegar samples.

Keywords

vinegar, radiocarbon assay, acetic acid, Permanganate Oxidation Number, isotopes, adulteration, non-biogenic acetic acid, fermentative acetic acid

Journal of Material Cycles and Waste Management, 25(6):3316-3330

Rare earths leaching from Philippine phosphogypsum using Taguchi method, regression, and artificial neural network analysis

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Abstract

The Philippines produce some 2.1–3.2 million t phosphogypsum (PG) per year. PG can contain elevated concentrations of rare earth elements (REEs). In this work, the leaching efficiency of the REEs from Philippine PG with H_2SO_4 was for the first time studied. A total of 18 experimental setups (repeated 3 times each) were conducted to optimize the acid concentration (1–10%), leaching temperature (40–80 °C), leaching time (5–120 min), and solid-to-liquid ratio (1:10–1:2) with the overall goal of maximizing the REE leaching efficiency. Applying different optimizations (Taguchi method, regression analysis and artificial neural network (ANN) analysis), a total REEs leaching efficiency of 71% (La 75%, Ce 72%, Nd 71% and Y 63%) was realized. Our results show the importance of the explanatory variables in the order of acid concentration > temperature > time > solid-to-liquid ratio. Based on the regression models, the REE leaching efficiencies are directly related to the linear combination of acid concentration, temperature, and time. Meanwhile, the ANN recognized the relevance of the solid-to-liquid ratio in the leaching process with an overall *R* of 0.97379. The proposed ANN model can be used to predict REE leaching efficiencies from PG with reasonable accuracy.

Keywords

phosphogypsum, rare earth elements (REEs), leaching, Taguchi method, artificial neural network

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Reactor physics analysis of a source-driven TRIGA configuration in subcritical domain

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Abstract

Subcritical reactors (SCR) are systems that are driven by an external source to achieve stationary state. Domainwide parametric study was performed elucidating the behavior of these systems on account of subcriticality level and source properties. Various configurations of the Philippine Research Reactor-1 Subcritical Assembly for Training, Education, and Research were modelled in MCNP6.2 as a representative SCR. Here we report the behavior of integral and distributed physics parameters. Results indicate that β_{eff} is constant, while prompt decay constant (α), subcritical multiplication factor (k_s), and neutron source efficiency (S_{eff}) increases, and Λ_{eff} decreases as k_{eff} increases. S_{eff} shows non-uniform behavior when $k_{eff} > 0.95$ suggesting that system response vary widely within this range. Furthermore, softer source spectrum resulted to higher performance metrics when located within the core, however at periphery, harder spectrum is advantageous. The findings clarify the physics of SCRs making possible system optimization and design of experiments targeting specific validation metrics.

Keywords

subcritical reactor, source-driven systems, subcritical multiplication factor, MCNP, neutron source efficiency

Soil physicochemical characteristics and spore density of indigenous arbuscular mycorrhizal fungi (AMF) in different vegetation patches of a marginal upland in central Philippines

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Abstract

To show the importance of plant-microbe association in stressed tropical landscapes, the study evaluated the physicochemical characteristics and indigenous arbuscular mycorrhizal fungi (AMF) spore density in selected vegetation patches of marginal upland soils in Central Philippines. Five quadrats were used in the study, namely Andropogon aciculatus (control plot), Imperata cylindrica, Chromolaena odorata, Melastoma malabathricum and mixed vegetation patch. Results showed that soils in the studied vegetation patches had different physicochemical characteristics and AMF spore density. Although all patches had clay soil texture and comparable waterholding capacity, mixed vegetation patch had moderate compaction (1.33 g cm^{-3}) and higher porosity (50.31%) compared with the other patches, which had extreme compaction (1.37-1.65 g cm^{-3}) and lower porosity (37.74-48.76%). In terms of chemical properties, soils in different patches had moderate (5.69) to strongly acidic pH (5.13), moderate organic matter (2.69-2.91%) levels, low P (2.67-3.94 ppm) content and above critical K levels (0.2-1.2 cmol+ kg^{-1}). Results also revealed that C. odorata patch had the highest spore density count (11.33 spores 100 g^{-1}), followed by mixed vegetation (9 spores 100 g^{-1}), M. malabathricum (8.33 spores 100 g^{-1}), and A. aciculatus patch having the lowest spore density count (4 spores 100 g^{-1}). The significant spore density variability was attributed to the differences in soil's physicochemical characteristics among the different vegetation patches and AMF host specificity. Spores detection, therefore, indicated AMF presence and helped the adaptation mechanism of the natural vegetation in this degraded upland.

Keywords

AMF, marginal upland, spore density, vegetation island

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Uranium supply potential from imported phosphate rocks for the Philippine nuclear power program

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Abstract

The Philippines is planning to rehabilitate its mothballed Bataan Nuclear Power Plant (BNPP) to provide affordable electricity and meet carbon emission goals. Despite not having domestic uranium resources, the Philippines import considerable amounts of phosphate rock for mineral fertilizer production that is known to contain between 50-200 mg uranium per kg ore. Recovering the uranium from phosphate rock during wetphosphoric acid (WPA) production, the process used in the Philippines, is a mature technology that was used at fertilizer plants in Florida in the 1980s and 1990s before decreasing uranium prices made it unprofitable. Uranium prices are bound to rise again, and this work estimates the amount of uranium that could be recovered during WPA production in the Philippines. We estimate that between 14.4-25.6 t natural uranium could have theoretically been recovered annually in 2020, 2021 and 2022. This amount is equivalent to approximately 12-21% of the projected annual uranium requirements of the BNPP. Phosphate rock imports into the Philippines are still below pre-Typhoon Haiyan levels and when the industry recovers it is likely that more than one-fourth of the uranium requirements of the BNPP could be met with unconventional uranium recovered from imported phosphate rocks.

Keywords

phosphate rock, uranium recovery, Philippines, fertilizer production, Bataan Nuclear Power Plant

Utilization of carbon isotopes for verifying the botanical source of oils employed in the cosmetic and food sectors

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Abstract

Oils devoid of added synthetic components, comprising solely of naturally derived plant products, are the preferred choice as primary materials for cosmetic manufacturing. While animal fats have also been utilized in conjunction with plant oils, a significant number of manufacturers have recently ceased their use due to concerns related to animal cruelty and Halal compliance. To ascertain the origins of the vegetable oil samples, a combination of Isotope Ratio Mass Spectrometry and Liquid Scintillation Spectrometry was employed. ensuring dependable data. Samples of coconut meat, palm pulp, corn ears, ginger tubers, and sesame seeds were acquired. The oils were extracted from these samples using steam distillation. Additionally, castor oil and mineral oil were procured from reputable sources The samples underwent analysis for both Carbon 13 ($\delta^{13}C$) and Carbon 14 levels. This analysis was carried out using an EA elemental analyzer connected to a Conflo isotope ratio mass spectrometer, as well as a TriCarb/TriSL liquid scintillation counter. The measured ^{14}C abundances in samples known to originate from authentic plants ranged from 11.5 to 19.5 disintegrations per minute per gram of carbon (dpm/g C), aligning with the contemporary Carbon (^{14}C) levels in the environment. Conversely, mineral oil and synthetie oils exhibited limited ^{14}C content, primarily containing fossil carbon (^{12}C), ranging from 0.0 to 2.0 dpm/g C. The variance in $\delta^{13}C$ distribution among the oils, determined by the type of photosynthesis (C_3 or C_4 plants), facilitated the identification of botanical origins and differentiation between oils derived from plants and animals.

Keywords

Isotope Ratio Mass Spectrometry, Liquid Scintillation Spectrometry, vegetable oils, C_3 plants, C_4 plants, cosmetic ingredients, cosmetic sector, food sector

List of Journals

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Journal	ISSN	WoS	Scopus	DOAJ
Analytical Letters	0003-2719 / 1532-236X	●	●	
Annals of Nuclear Energy	0306-4549 / 1873-2100	●	●	
Arabian Journal for Science and Engineering	2193-567X / 2191-4281	●	●	
Asia Life Sciences: The Asian International Journal of Life Sciences	0117-3375			
Clay Minerals	0009-8558 / 1471-8030	●	●	
Heliyon	2405-8440	●	●	●
International Journal of Nano Dimension	2008-8868 / 2228-5059	●	●	
Journal of Cleaner Production	0959-6526 / 1879-1786	●	●	
Journal of Material Cycles and Waste Management	1438-4957 / 1611-8227	●	●	
Journal of Polymers and the Environment	1566-2543 / 1572-8919	●	●	
Marine Pollution Bulletin	0025-326X / 1879-3363	●	●	
Mindanao Journal Science and Technology	2244-0410 / 2449-3686	●	●	

Journal	ISSN	WoS	Scopus	DOAJ
Molecular Biology Research Communications	2322-181X / 2345-2005	●	●	
Philippine Journal of Science	0031-7683	●	●	
Plant Growth Regulation	0167-6903 / 1573-5087	●	●	
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Radiation Protection Dosimetry	0144-8420 / 1742-3406	●	●	
Radiology: Cardiothoracic Imaging	2638-6135	●	●	
Results in Optics	2666-9501	●	●	●
SAINS TANAH - Journal of Soil Science and Agroclimatogology	1412-3606 / 2356-1424	●	●	●
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