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Section Ecology Science and Engineering

A vertical strip on the left side of the page features a microscopic image of biological cells, possibly plant tissue, showing various cell structures and colors in shades of blue and purple.

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Selected Papers



Extended Bibliometric Review of Technical Challenges in Mariculture Production and Research Hotspot Analysis

Authors: Tena Bujas, Nikola Vladimir, Marija Koričan, Manuela Vukić, Ivan Čatipović and Ailong Fan

Abstract: The growth in population and the higher need for aquatic products make the aquaculture industry the world's fastest-growing food industry. With its rapid development, production is facing various challenges to achieve sustainability and cost-effectiveness. Some obstacles in production are related to the design of mariculture cages, automatization, location of the farm, biofouling, feeding, waste management, and others. This paper deals with the extended bibliometric analysis of technical problems in mariculture based on keywords, citations, journals, and other factors by means of scientometric software, CiteSpace, and VOSviewer. Important keywords related to aquaculture and mariculture were obtained from the Web of Science platform and further analyzed by means of the mentioned scientometric software offering knowledge domain visualization and construction of knowledge maps. Apart from the identification of research topics of the highest importance, research hotspots are characterized as follows: technical, biological, digital, and environmental. The most cited articles are related to the environmental problems and solutions in marine aquaculture and the study of biofouling and how to control it. Other important documents with high citation rates are related to the cages, offshore mariculture, location conditions, and sustainability. This study recognizes trends by combining aquaculture production with floating structures for energy extraction of sea resources; thus, making aquaculture more interdisciplinary than before.

<https://doi.org/10.3390/app13116699>



Combined Remediation Effects of Pioneer Plants and Solid Waste towards Cd- and As-Contaminated Farmland Soil

Authors: Jiamei Wu, Chenxu Zhang, Huifen Yang, Pan Chen and Jian Cao

Abstract: The development of phytoremediation technology is constrained by gentle phytoextraction efficiency and slow biomass accumulation. In this study, a combined remediation of pioneer plants and solid waste towards Cd- and As-contaminated farmland soil was explored. Pioneer plants *Cynodon dactylon* and two material formulas (Steel slag (SS);pyrolusite (PY):ferrous sulfide (FS) = 3:3:2 or 1:2:8) were used in pot experiments. The DTPA method was used to extract the bioavailable heavy metals from soil, and then, the reduction rates of the bioavailable heavy metals were calculated. After harvesting plants, data of moisture content, biomass, root length and plant height were obtained. The remediation effect was evaluated according to the above indexes. The experimental results showed that the remediation effect of *Bidentis pilosa* was better than that of *Cynodon dactylon*. The addition of solid waste material significantly reduced the content of bioavailable Cd and As in soil by 97.73% and 53.54%, respectively. Suitable wastes may be a potential addition to heavy metal contaminated soils to promote phytoremediation of heavy metals.

<https://doi.org/10.3390/app13095695>



Long-Term Pre-Treatment of Municipal Sewage Sludge with Solidified Carbon Dioxide (SCO₂)—Effect on Anaerobic Digestion Efficiency

Authors: Joanna Kazimierowicz, Marcin Dębowski and Marcin Zieliński

Abstract: Studies on harnessing solidified carbon dioxide (SCO₂) for municipal sewage sludge (MSS) pre-treatment have been conducted exclusively in batch reactors. This makes it difficult to accurately assess how long-term SCO₂ treatment affects anaerobic digestion (AD) conditions and performance. The aim of our study was to evaluate the effect of long-term MSS pre-treatment with SCO₂ on AD conditions, anaerobic bacterial community, and biogas composition and yields. The presented experiments are the first studies on the effect of pre-treatment with SCO₂ on the efficiency of AD of MSS in continuous reactors. So far, the impact of the organic load rate (OLR) on the efficiency of MSS methane fermentation has not been assessed, which is also a novelty of the conducted research. The AD process was conducted in continuous-stirred, continuous-flow anaerobic with an active volume of 20 dm³. The digestion process was run at 38 ± 1 °C. The experiment was divided into two stages. Raw (non-pretreated) MSS was used in stage 1, whereas the MSS used in stage 2 was pre-treated with SCO₂. The SCO₂/MSS ratio was 1:3. Each stage was sub-divided into four variants, with different levels of the OLR ranging from 2.0 to 5.0 gCOD/dm³-day. Pre-treatment with SCO₂ was found to improve AD performance at an OLR of 3.0–4.0 gVS/dm³-day. The 3.0 gVS/dm³-day variant offered the best biogas production performance—both daily (29 ± 1.3 dm³/day) and per VS added (0.49 ± 0.02 dm³/gVS)—as well as the highest CH₄ content in the biogas (70.1 ± 1.0%). In this variant, the highest energy output effect of 187.07 ± 1.5 Wh/day was obtained. The SCO₂ pre-treatment was not found to change the pH, FOS/TAC, or the anaerobic bacterial community composition. Instead, these variables were mainly affected by the OLR. Our study shows that MSS pre-treatment with SCO₂ at a SCO₂/MSS ratio of 0.3 (by volume) significantly improves AD performance in terms of methane production and feedstock mineralization. The pre-treatment was found to have no negative effect on the long-term continuous operation of the reactor.

<https://doi.org/10.3390/app13053075>



Constant and Intermittent Contact with the Volatile Organic Compounds of *Serendipita indica* Alleviate Salt Stress In Vitro *Ocimum basilicum* L.

Authors: Hassiba Fraj and Stefaan P. O. Werbruck.

Abstract: *Serendipita indica* is a plant growth-promoting fungus. It is a natural soil dweller that can colonize the roots of a wide range of plants, including cultivated crops. *S. indica* has been reported to improve plant nutrient uptake and increase stress tolerance when inoculated into the soil. The present study was undertaken to study the effect of volatile organic compounds (VOCs) of *S. indica* on salt-stressed *Ocimum basilicum* 'Fin vert' in vitro, either in a culture vessel with a semi-solid medium or via a modified temporary immersion bioreactor system (SETIS). For all salt concentrations, VOCs of *S. indica* significantly improved plant growth in both semi-solid medium and SETIS bioreactors. This resulted in heavier and taller plants, more shoots per plant, and longer roots. This was even observed for the control without salt. At 9 g/L NaCl, plants with *Serendipita* were able to give longer roots than those without (1.2 cm vs. 0.0 and 1.7 cm vs. 1.7 cm) in the semi-solid medium and SETIS, respectively. Nevertheless, the VOCs were not able to make the plant salt tolerant to this high concentration. The increase in total phenolic and flavonoid content and radical scavenging suggest that the antioxidant defense system is triggered by the *S. indica* VOCs. In the semi-solid system, without VOCs, 1 g/L NaCl led to an increase in total chlorophyll content (TCC) and a significant decrease in TCC was further measured only at 6 g/L NaCl or more. However, when VOCs were added, the bleaching effect of the salt was partially restored, even at 6 and 9 g/L NaCl. A significant decrease in TCC was also measured in the SETIS system at 6 g/L NaCl or more and treatment with VOC did not make any difference. An exception was 9 g/L, where the VOC-treated plants produced more than three times more chlorophyll than the non-treated plants. These findings will encourage the application of *Serendipita indica* for stress reduction. In addition, the proposed original adaptation of a temporary immersion system will be instrumental to investigate stress reduction associated with volatile compounds and better understand their mechanism of action.

<https://doi.org/10.3390/app13031776>

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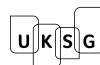
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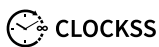
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Editorial Office

applsci@mdpi.com

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Grosspeteranlage 5
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