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Editorial

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How the unique diversity of extreme cyanobacteria can hold the key to novel algae-based products

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The treatment of domestic solid waste generates a highly toxic byproduct known as leachate. These landfill leachates represent an imminent risk to human health and the environment due to high concentrations of dissolved organic and inorganic compounds such as nitrites, ammonia nitrogen, total phosphorus, Chemical oxygen demand, and biological oxygen demand 5 (BOD5), as well as heavy metals such as aluminum, arsenic, cyanide, cobalt, copper, chromium, mercury, chromium, zinc, and others. The main negative effects of the presence of leachates include contamination of soils, surface water, and groundwater, where there are problems in the proper growth of plants, alteration of optimal soil conditions, and eutrophication and toxicity in bodies of water, generating a change in native flora and fauna and bioaccumulation of heavy metals that will be transmitted throughout the food web, among other alterations.

The different companies in charge of solid waste disposal seek strategies to minimize risks and comply with current environmental policies. Currently, most landfills in Latin America have leachate storage systems to facilitate the evaporation and passive concentration of this waste. Other companies use reverse osmosis systems to concentrate the different contaminants and recover the water. Implementing strategies to reduce environmental and public health risks in the landfill sector is a priority and challenge for government agencies and disposal companies. Several physicochemical and biological processes have been extensively studied in leachate treatment; however, despite the efficiency demonstrated, the high costs of the materials and equipment required, as well as the high energy consumption, make them unsustainable.

Over the last years, microalgae and cyanobacteria have obtained a privileged place in the global biotechnological spotlight since their large diversity can unlock novel metabolites that can improve the creation of existing and new products.

One of the most interesting applications of microalgae and cyanobacteria is the removal of nutrients from polluted waters, better known as phytoremediation. Phytoremediation using microalgae is not new; the first studies were carried out in San Obispo (California) by Prof. William J. Oswald's group in the mid-1950s. By employing this principle, it is possible to transform certain effluents while reducing their impact and producing biomass with metabolites of industrial interest[1].

To understand a little more about the scientific interest in phytoremediation, a search was conducted in SCOPUS for the last 22 years (2000-2022) using the keywords "leachate" AND "landfill" AND "microalgae". According to this search, it was possible to identify 166 documents [Figure 1A] published during this period, where the main countries where research processes in this area have been developed are China (29), the United States (29), Denmark (16), and others [Figure 1B].

The information presented in the previous section made it possible to identify the co-occurrence of the main keywords using VOSViewer software. According to the results, four clusters were found [Figure 2]. The 4 clusters can be distinguished and separated by colors. The main clusters refer to the physical conditions for leachate and algae capture (green), while the others group the keywords for landfill treatment conditions (red) and their environmental impact (blue). It should also be noted that the valorization of this biomass and its environmental impact is not yet a topic of great relevance in the literature, so the technical and scientific void is evident.

One of the main problems for efficient leachate treatment using microalgae or cyanobacteria is strain selection. Due to the unique chemical composition of this type of waste, and the high diversity of microalgae and cyanobacteria, there is no "optimal strain" thus far. Hence, it is necessary to isolate and identify the strain (or strains) that have the highest nutrient removal capacity.

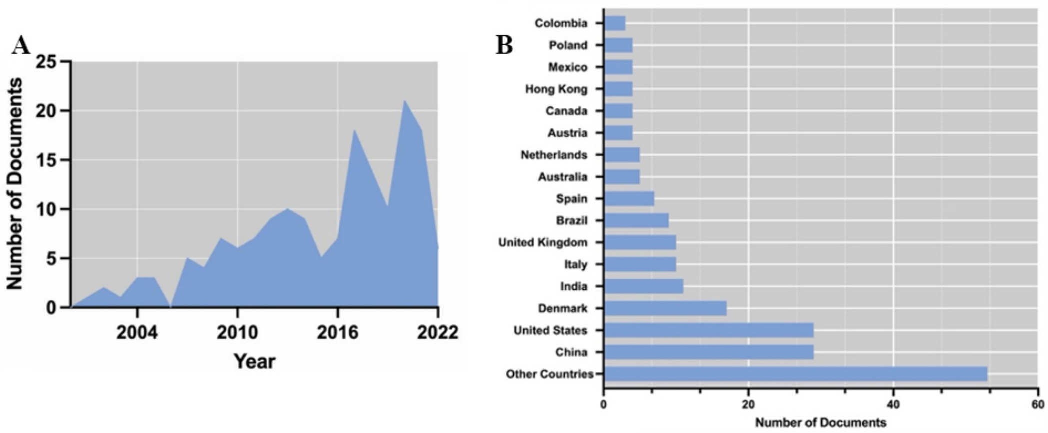

Figure 1. (A) Number of documents published during the last 22 years and (B) countries with the highest number of publications[2].

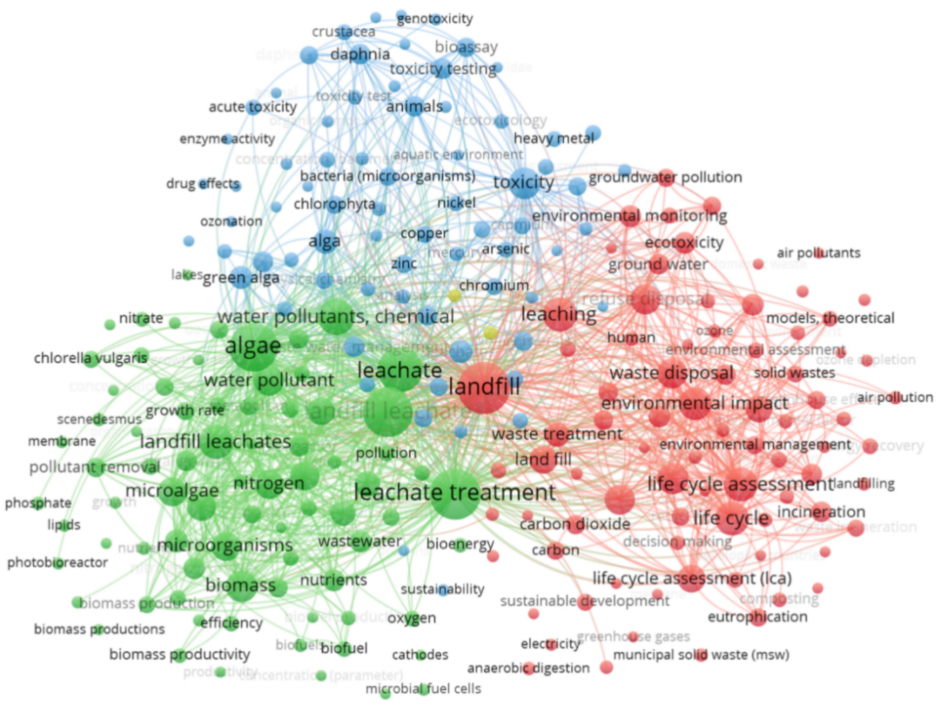

Figure 2. Co-occurrence analysis of the information collected.

DECLARATIONS

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Authors' contributions

Conceptualization, methodology, software, validation, formal analysis, investigation, data curation, writing-original draft preparation: Zuorro A, García-Matínez JB, Barajas-Solano AF

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Conflicts of interest

All authors declared that there are no conflicts of interest.

Ethical approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

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