UNIDAD DE VIGILANCIA TECNOLÓGICA E INTELIGENCIA COMPETITIVA

Microalgas

Diciembre de 2022

Ministerio de Agricultura, Ganadería y Pesca
Argentina

Contenido

PUBLICACIONES

Investigating the potentiality of Scenedesmus obliquus and Acinetobacter pittii partnership system and their effects on nutrients removal from synthetic domestic wastewater

Autor: Mohammad Russel

Bioresour Technol. 2020

ABSTRACT

A lab-scale study of Scenedesmus obliquus: Acinetobacter pittii (S. obliquus: A. pitti) partnership cultured in synthetic domestic wastewater was conducted to evaluate the partnership performance for growth and removal of nutrients from wastewater. To draw out the functional dependencies of this partnership measured the ammonia-nitrogen (NH4+-N), ortho-phosphate (PO43--P), soluble total phosphorus (TP), chemical oxygen demand (COD) and have got the nutrient removal rate of 85.90%, 91.50%, 73.75% and 100% respectively. The results showed that their optimized partnership ratio is 2:1 for S. obliquus: A. pitti and, CO2 & O2 exchanges in between was the more crucial parameters to shifting the best nutrient removals performance and promoted biomass quantity.

An integrated approach for tannery effluent treatment with ozonation and phycoremediation: A feasibility study

Autor: D Saranya

Environ Res. 2020

ABSTRACT

For the exploration of an effective and economical method to treat composite raw tannery effluent, the integrated approach of Ozonation and phycoremediation was followed. In a lab-scale Ozone reactor, the highest performance index was attained, when it was operated at a low O3 flowrate (2 g/h) condition. The tannery effluent partially treated by Ozonation (≈60% COD removed in 90 min) with the ozone consumption of 1.5 g of O3/g of COD, at pH 7.6, coupled with phycoremediation had improved the tannery effluent characteristics to a considerable extent. Overall, the maximum reduction in pollutant concentration attained with the combined treatment was 84% for COD, 60% for colour, 100% for odour, 90% for inorganic carbon, 82% for NH4+- N, 100% for PO4-P, 97% for chromium and 10% for TDS. In phycoremediation, microalgae Nannochloropsis oculata had shown an enhanced growth (μ = 0.255 day-1) with a maximum cell density of 5.2 × 107 cells/mL, dry biomass of 0.86 g L-1 and cell division rate of 0.369 day-1. Elemental analysis of biomass validated the chromium remediation along with other elements such as calcium, magnesium, sodium, potassium, zinc, and iron from the tannery effluent. Therefore, the phycoremediation integrated ozone process can be considered as a feasible treatment method for tannery effluent along with value-added biomass production.

Phycoremediation and valorization of synthetic dairy wastewater using microalgal consortia of Chlorella variabilis and Scenedesmus obliquus

Autor: Bhalamurugan Gatamaneni Loganathan

Environ Technol. 2021

ABSTRACT

Microalgae are known to grow on wastewater utilizing their available nutrients. The residual algal biomass thus obtained could be used for producing value-added products thereby making it an economically viable and sustainable option for the dairy industry. The present study evaluates the ability of the microalgal consortia composed of Chlorella variabilis and Scenedesmus obliquus to treat and valorize diluted synthetic dairy wastewater under controlled laboratory conditions. The effect of time, inoculum concentration and light intensity on five responses, namely phosphate removal, ammoniacal nitrogen removal, COD removal, biomass productivity and lutein content, are studied by response surface methodology utilizing central composite design. The quadratic models are found to be suitable for phosphate removal, ammoniacal nitrogen removal, COD removal and biomass productivity. At optimized experimental conditions, the microalgal consortia exhibited phosphate removal of 70.19%, ammoniacal nitrogen removal of 86.22%, COD removal of 54.72%, biomass productivity of 29.13 mg/L/day and lutein content of 12.59 mg/g respectively. This study is of high importance as the lutein content exhibited by the microalgal consortia is higher when compared to other microalgal species and could be considered in the future as a commercial source of lutein.

Upgrading of microalgal consortia with CO(2) from fermentation of wheat straw for the phycoremediation of domestic wastewater

Autor: Jyoti Sharma

Bioresour Technol. 2020 Feb 21;305:123063.

ABSTRACT

Algae have been considered as a best feedstock for combating CO2. In the present study, two mixed microalgal cultures i.e. MAC1 and MAC2 were evaluated in batch mode with an extraneous supply of CO2 from the fermentation of wheat straw. Both the mixed cultures displayed promising CO2 sequestration potentials of 287 and 263 mg L-1d-1, respectively. The removal efficiencies in terms of ammonium, phosphate, chemical oxygen demand, and nitrate were found to be 87%, 78%, 68% and 65%, respectively. Enriching the tolerance of the microalgal consortia to CO2 supply and wastewater as the nutrient source significantly enhanced the lipid production for both the microalgae consortia. Lipid contents of MAC1 and MAC2 were observed to be 12.29 & 11.37%, respectively while the biomass yield from both the consortia was 0.36 g L-1. Total chlorophyll and protein contents of MAC1 and MAC2 were 14.27 & 12.28 μgmL-1 and 0.13 & 0.15 mgmL-1, respectively. Both the consortia found to have significant potential for CO2 sequestration, wastewater remediation and biofuel production.

Microalgae-bacteria consortia in high-rate ponds for treating urban wastewater: Elucidating the key state indicators under dynamic conditions

Autor: Ángel Robles

J Environ Manage. 2020

ABSTRACT

On-line performance indicators of a microalgae-bacteria consortium were screened out from different variables based on pH and dissolved oxygen on-line measurements via multivariate projection analysis, aiming at finding on-line key state indicators to easily monitor the process. To fulfil this objective, a pilot-scale high-rate pond for urban wastewater treatment was evaluated under highly variable conditions, i.e. during the start-up period. The system was started-up without seed of either bacterial or microalgal

biomass. It took around 19 days to fully develop a microalgal community assimilating nutrients significantly. Slight increases in the biomass productivities in days 26-30 suggest that the minimum time for establishing a performant bacteria-microalgae consortium could be of around one month for non-inoculated systems. At this point, the process was fully functional, meeting the European discharge limits for protected areas. The results of the statistical analyses show that both the pH and the dissolved oxygen concentration represent accurately the biochemical processes taking place under the start-up of the process. Both pH and dissolved oxygen represented accurately also the performance of the high-rate algal pond, being affordable, easily-implemented, options for monitoring, control and optimization of industrial-scale processes.

A comprehensive study on the effect of light quality imparted by light-emitting diodes (LEDs) on the physiological and biochemical properties of the microalgal consortia of Chlorella variabilis and Scenedesmus obliquus cultivated in dairy wastewater

Autor: Bhalamurugan Gatamaneni Loganathan

Bioprocess Biosyst Eng. 2020

ABSTRACT

The effect of light wavelengths on the physiological, biochemical and lutein content of the microalgal consortia Chlorella variabilis and Scenedesmus obliquus was evaluated using different light sources. Among different light treatments, cool-white fluorescent light produced the highest biomass of 673 mg L-1 with a specific growth rate of 0.75 day-1 followed by blue (500 mg L-1; 0.73 day-1). The chlorophyll content was enhanced under blue light (10.7 mg L-1) followed by cool fluorescent light (9.3 mg L-1), whereas the lutein productivity was enhanced under cool fluorescent light (7.22 mg g-1). Protein content of the microalgal consortia was enhanced under all light treatments with the highest protein accumulation under cool-white fluorescent light (~56% of dry mass) closely followed by amber light (52% of dry mass), whereas the carbohydrate content was higher under amber light (~35% of dry mass). The results revealed that the consortia could grow well on diluted dairy wastewater thereby reducing the cost of algal production when compared with the use of inorganic media and a two-phase culture process utilizing cool fluorescent and amber light could be employed for maximizing algal biomass and nutrient composition with enhanced lutein production. The study also emphasizes on the economic efficiency of LED lights in terms of biomass produced based on the modest electricity consumed and the importance of using amber light for cultivating microalgae for its nutrient content which has seldom been studied.

Microalgae Cultivation Using Screened Liquid Dairy Manure Applying Different Folds of Dilution: Nutrient Reduction Analysis with Emphasis on Phosphorus Removal

Autor: Liang Wang

Appl Biochem Biotechnol. 2020

ABSTRACT

A number of dairies in southern Idaho employed stationary inclined screens to separate large solid particles out of liquid dairy manure. In this way, the total solid content of the liquid dairy manure can drop about 20%. Solids in dairy wastewater cause high turbidities, which could block the incident light, a key factor in the microalgae cultivation process using wastewaters as culture media. In this study, screened liquid dairy manure was used as the microalgae Chlorella vulgaris culture media. The aim was to optimize the dilution folds for the best growth of Chlorella vulgaris and nutrients' reduction with a special focus on phosphorus removal and recovery. Four folds of dilution, designated as 5*, 10*, 15*,

20*, were applied to the liquid dairy manure to alleviate hindrance of the high turbidity together with the high ammonium. Microalgal cultivation removed a significant amount of turbidity and major nutrients. For differently diluted liquid dairy manures, although the initial turbidities varied a lot, the final removal rates were not significantly different, falling in the range of 88.11-91.73%. Chemical oxygen demand (COD) in the 5-fold diluted liquid dairy manure dropped from 6700 to 1200 mg/L, corresponding to a removal rate of 79.81%. For the 10-fold, 15-fold, and 20-fold diluted manures, Chlorella removed around 67-69% of the initial CODs. Total Kjeldahl nitrogen (TKN) was removed at rates ranging from 70.84 to 73.99% from the four differently diluted liquid dairy manures without significant differences. NH4-N was removed most efficiently by 88.92% from the 20-fold diluted liquid dairy manure, and the least at 68.65% from the 5-fold diluted one. Although the original total phosphorus (TP) concentrations were distinctive for each group, the TP removal rates stayed in the range of 52.16 to 65.22%. Scanning electron microscopy (SEM) and energy-dispersive spectrometry (EDS) analysis of the precipitates harvested from the microalgal cultivation suggested possible phosphate precipitate forms. The chelation of Ca or Mg cations by dissolved organic matter (DOM) under alkaline conditions caused by microalgae cultivation could explain the unsatisfactory phosphorus removals observed in this study.

Utilization of domestic wastewater as a water source of Tetradesmusobliquus PF3 for the biological removal of nitric oxide

Autor: Shanshan Ma

Environ Pollut. 2020

ABSTRACT

The reduction of nitrogen oxide (DeNOx) from flue gas by microalgae is a promising technology that has attracted increasing attention. Because the water source is a major limitation of microalgae application in the DeNOx from flue gas, we investigated the feasibility of using domestic wastewater (WW) as a water source. As a result, a biomass accumulation rate of 0.27 ± 0.01 mg L-1 d-1 was achieved by Tetradesmusobliquus PF3 cultivated in WW for 8 d, and 30 mg L-1 of nitrate nitrogen was added to the WW to fulfill the nutrient requirements of the microalgae cells. The ammonium (NH4+) nitrogen present in WW exerted inhibitory effects on the removal of nitric oxide (NO), thereby leading to 8% decrease removal efficiency in comparison with that using clean water and nutrients (BG11 medium). However, these inhibitory effects disappeared following the exhaustion of NH4+ by T. obliquus PF3 after 1 d. To overcome the inhibition of NH4+ and to achieve a high NO removal efficiency, a strategy of connecting two reactors in series was presented. The removal efficiency of NO by the two series reactors reached up to 71.2 ± 2.9%, which was significantly higher than that obtained by a single reactor (43.1 ± 3.6%). In addition, 70.9 ± 4.8% of the supplied NO was fixed into microalgae cells in the two reactors, which was 1.75 times higher than that in the single reactor (40.6 ± 5.1%), thereby suggesting that connecting two reactors in series rendered effective recovery of NO from flue gas using WW as a water source. In this study, we provided an economically viable water source for the application of microalgae in the biological DeNOx from flue gases.

Sustainable treatment of domestic wastewater through microalgae

Autor: Nandini Moondra

Int J Phytoremediation. 2020

ABSTRACT

The present work evaluated the optimum concentration of microalgal cells for domestic wastewater treatment in terms of removal in nutrients and physicochemical parameters. In the study, three different concentrations (20, 30, and 40%) of microalgae was considered at 8 hours and 24 hours of Hydraulic Retention time (HRT). Among the different microalgal concentrations studied 30% microalgae concentration gave maximum removal at both the

HRTs. The maximum removal efficiency of phosphate, ammonia and COD for the non-filtered sample was 87.67, 96.88, and 80.39%, respectively, for filtered sample it was about 91.32, 100, and 83.64%, respectively at 8 hours HRT. However, at 24 hours HRT maximum removal efficiency observed was 97.92, 92.22, and 93.47% for ammonia, COD and phosphate respectively in case of non-filtered sample whereas in filtered samples maximum removal efficiency was 100, 94.44, and 95.51% for ammonia, COD and phosphate respectively. From the study, it was found that microalgae can effectively remove nutrients and organic contents to desirable limits even at a low HRT of 8 hours. At the urban sector, if microalgae are incorporated in a conventional wastewater treatment system will enhance the cost-effective efficiency by lowering the HRT and increasing the removal efficiency with footprints of sustainable treatment.

Dairy Manure Wastewater Remediation Using Non-airtight Digestion Pretreatment Followed by Microalgae Cultivation

Autor: Liang Wang

Appl Biochem Biotechnol. 2020

ABSTRACT

The non-airtight digestion technology is emerging to be applied in the acidogenic phase for two-stage methane production. However, in this study, it was used to pretreat screened dairy manure (SDM) in order to provide microalgae cultivation with a substrate that might be more suitable for nutrient reduction, especially phosphorus. SDM was firstly underwent non-airtight digestion applying different dilution folds, i.e., blank (no dilution), 5-fold, 10-fold, and 15-fold. Total solids (TS), total dissolved solids (TDS), and chemical oxygen demand (COD) of the SDM were mostly reduced when there was no dilution applied. Five-fold dilution is the most beneficial one for ammonia reduction. Total phosphorus (TP) was reduced the most efficiently in the blank SDM. After the non-airtight digestion, 5-fold diluted original SDM, 5-fold diluted digested original SDM, and digested 5-fold diluted SDM were used to grow microalgae for 8 days. Microalgae grown in 5-fold diluted digested original SDM and digested 5-fold diluted SDM had better removal efficiencies in COD and NH4-N. From the monitoring of pH and TP during the 8-day culture period, it is found that pHs were peaked on the 4th day for microalgae grown in 5-fold diluted digested original SDM and digested 5-fold diluted SDM, corresponding to the maximal TP removal. Non-airtight digestion of SDM could help achieve better nutrient removal by microalgal cultivation in a shorter time span.

Sustainable livestock wastewater treatment via phytoremediation: Current status and future perspectives

Autor: Hao Hu

Bioresour Technol. 2020

ABSTRACT

Phytoremediation, the application of vegetation and microorganisms for recovery of nutrients and decontamination of the environment, has emerged as a low-cost, eco-friendly, and sustainable approach compared to traditional biological and physico-chemical processes. Livestock wastewater is one of the most severe pollution sources to the environment and water resources. When properly handled, livestock wastewater could be an important alternative water resource in water-scarce regions. This review discussed the characteristics and hazards of different types of livestock wastewater and available methods for the treatment. Meanwhile, the current status of investigations on phytoremediation of livestock wastewater via different hydrophyte systems such as microalgae, duckweed, water hyacinth, constructed wetlands, and other hydrophytes is reviewed, and the utilization of hydrophytes after management is also discussed. Furthermore, advantages and limitations on livestock wastewater management via phytotechnologies are emphasized. At last, future research needs are also proposed.

Wastewater based microalgal biorefinery for bioenergy production: Progress and challenges

Autor: Shashi Kant Bhatia

Sci Total Environ. 2021

ABSTRACT

Treatment of industrial and domestic wastewater is very important to protect downstream users from health risks and meet the freshwater demand of the ever-increasing world population. Different types of wastewater (textile, dairy, pharmaceutical, swine, municipal, etc.) vary in composition and require different treatment strategies. Wastewater management and treatment is an expensive process; hence, it is important to integrate relevant technology into this process to make it more feasible and cost-effective. Wastewater treatment using microalgae-based technology could be a global solution for resource recovery from wastewater and to provide affordable feedstock for bioenergy (biodiesel, biohydrogen, bio-alcohol, methane, and bioelectricity) production. Various microalgal cultivation systems (open or closed photobioreactors), turf scrubber, and hybrid systems have been developed. Although many algal biomass harvesting methods (physical, chemical, biological, and electromagnetic) have been reported, it is still an expensive process. In this review article, resource recovery from wastewater using algal cultivation, biomass harvesting, and various technologies applied in converting algal biomass into bioenergy, along with the various challenges that are encountered are discussed in brief.

PMID:32890799 | DOI:10.1016/j.scitotenv.2020.141599

Effect of light intensity and wavelength on nitrogen and phosphate removal from municipal wastewater by microalgae under semi-batch cultivation

Autor: Mahsa Bahman

Environ Technol. 2020

ABSTRACT

Domestic, agricultural and industrial water activities lead to organic and inorganic pollution of the environment. Biotreatment of municipal wastewater with the potential production of biomass is a valuable feature of microalgae. In this study we evaluated the effects of wavelength and light intensity on phosphate and ammonium removal on the one hand, and biomass and protein production on the other hand by Spirulina platensis in municipal wastewater treatment under semi batch cultivation. S. platensis was inoculated at 40% in artificial wastewater open pond system. Red, blue and purple light with 3800, 4800 and 5800 lux light intensity under 12 h light and 12 h darkness were investigated. Cultivation was conducted in semi-batch conditions; after four days cultivation, one third of the culture was replaced with fresh medium. The highest biomass and protein concentrations were observed under blue light at 5800 lux light intensity, 5.45 and 3 g/l respectively cumulatively; while the highest amount of phosphate and ammonium removal were about 145 and 218 mg/l under purple light at 5800 lux intensity, respectively. The amounts of biomass and protein produced, as well as phosphate and ammonium removed, are therefore impacted by wavelength, light intensity, results show that light intensity and wavelength can be customized to reach on the one hand the highest biomass and protein production, and on the other hand to maximize the removal of phosphorous and ammonium.

Wastewater treatment by microalgal membrane bioreactor: Evaluating the effect of organic loading rate and hydraulic residence time

Autor: A K M Ashadullah

J Environ Manage. 2021

ABSTRACT

Current microalgal based photobioreactors focus on the secondary treated effluent while limited researches attempted for treating the raw domestic wastewater. This study aimed to assess the microalgal biomass production, removal performance, and fouling characteristics of microalgal membrane bioreactors (MMBRs) for treating synthetic wastewater under different conditions of organic loading rate (OLR) and hydraulic residence time (HRT). The 12h/12 h dark/light cycle continuous experiments were performed for four MMBRs at different OLRs and three MMBRs at different HRTs. Results showed that microalgal biomass production rate (as TSS and chlorophyll-a) decreased with increasing OLR and increased with decreasing of HRT. Regardless of the OLR and HRT conditions, MMBRs can achieve up to 94% organic removal by bacterial oxidation without external aeration. Total nitrogen (TN) and total phosphorus (TP) removals were significantly decreased with increasing OLR. Highest TN removal (68.4%) achieved at the OLR of 0.014 kg/(m3 d) which was reduced to 58.1% at 0.028 kg/(m3 d). Removals of total phosphorous significantly decreased from 48.2% to 37.7% with an increase in OLR from 0.011 to 0.014 kg/(m3 d). TN removal was reduced at shorten HRT (2 d), while, the effect of HRT was found insignificant at higher HRT. An effective removal of P can only be achieved at higher HRTs, i.e., 7 days. OLR up to 0.014 kg/(m3 d) and 2 days HRT was found suitable for maintaining the fouling frequency at an optimal level of 0.016/d. Overall the OLR and HRT need to be carefully selected to achieve optimal efficiency of MMBR. The results of this study provide guidelines for designing the microalgal-based membrane bioreactors for the treatment of domestic wastewater.

Removal of nutrients from domestic wastewater by microalgae coupled to lipid augmentation for biodiesel production and influence of deoiled algal biomass as biofertilizer for Solanum lycopersicum cultivation

Autor: Sivagnanam Silambarasan

Chemosphere. 2021 Apr;268:129323. doi: 10.1016/j.chemosphere.2020.129323. Epub 2020 Dec 15.

ABSTRACT

In this study, Chlorella sp., Scenedesmus sp., and their consortium were used for the biorefinery approach. The algal consortium (Chlorella sp. + Scenedesmus sp.) grown well in 75% diluted wastewater, and obtained the highest biomass (1.78 g L-1), chlorophyll (27.03 μg mL-1), protein (175 μg mL-1) and lipid content (34.83% dry cell weight). Algal consortium showed mainly 51.75% of palmitic acid and 35.45% of oleic acid in the lipids. The removal of nitrate, ammonium, phosphate, chemical oxygen demand, total organic carbon and total nitrogen in 75% diluted wastewater by algal consortium were 96%, 98%, 95%, 83%, 86% and 94%, respectively. Moreover, deoiled algal biomass (DAB) waste used as a biofertilizer combined with inorganic fertilizer resulted in the grater improvement of Solanum lycopersicum shoot length (44%), root length (89%), fresh weight (95%), dry weight (53%), macro and micro-nutrients (N 61%, P 179%, K 71%, Ca 38%, Mg 26% and Fe 11%), and tomato yield (174%) as compared to control treatment. Our results indicate that the use of consortium is not only a potential bioresource for wastewater treatment and biodiesel production but also the DAB waste is an effective biofertilizer for sustainable agriculture production.

An eco-friendly strategy for dairy wastewater remediation with high lipid microalgae-bacterial biomass production

Autor: Tethi Biswas

J Environ Manage. 2021

ABSTRACT

The present study attempts to integrate phyco-remediation and enhanced lipid productivity using microalgae-bacterial consortium enriched from wastewater fed aquaculture pond. Metagenomic analyses and microscopic images of the consortium revealed the presence of Chlorella variabilis, Parachlorella kessleri, Thermosynechococcus elongatus, Chlamydomonas, Phaeodactylum tricornutum, Oscillatoriales, Synechocystis sp., Microcystis aeruginosa, Nostocales, Naviculales, Stramenopiles, other members of Chlorophyceae, Trebouxiophyceae, and Chroococcales along with potential bacterial bioremediants. During a 30 days trial run (15 days stabilization and 14 days remediation studies) for phyco-remediation drastic reduction in the nutrient and COD content from the tested wastewater samples was seen. There was up to 93% and 87.2% reduction in chemical oxygen demand (COD) and ammonium concentration, respectively. Further, almost 100% removal of nitrates and phosphates from the dairy wastewater upon 48 h of treatment with polyculture under ambient temperature (25 ± 2 °C) with 6309 lux illumination and mild aeration, was observed for all the seven cycles. Interestingly, the nutrient and COD concentrations in the treated water were below the discharge standards as per Central Pollution Control Board (CPCB) norms. In additions, biomass (reported as dry cell weight) was enhanced by 67% upon treatment with ammonia-rich dairy wastewater exhibiting 42% lipid, 55% carbohydrate, and 18.6% protein content enhancement. The polyculture mainly grown as attached biofilm to the surface, offered an easy harvesting and separation of grown biomass from the treated wastewater. Overall, dairy wastewater was found to be a potential nutrient source for microalgae-bacteria cultivation thereby making the treatment process sustainable and eco-friendly.

Insights into upstream processing of microalgae: A review

Autor: Ehsan Daneshvar

Bioresour Technol. 2021

ABSTRACT

The aim of this review is to provide insights into the upstream processing of microalgae, and to highlight the advantages of each step. This review discusses the most important steps of the upstream processing in microalgae research such as cultivation modes, photobioreactors design, preparation of culture medium, control of environmental factors, supply of microalgae seeds and monitoring of microalgal growth. An extensive list of bioreactors and their working volumes used, elemental composition of some well-known formulated cultivation media, different types of wastewater used for microalgal cultivation and environmental variables studied in microalgae research has been compiled in this review from the vast literature. This review also highlights existing challenges and knowledge gaps in upstream processing of microalgae and future research needs are suggested.

Spatiotemporal variations in the composition of algal mats in wastewater treatment ponds of tannery industry

Autor: Iman Dey

Environ Monit Assess. 2021

ABSTRACT

Wastewater Treatment Pond (WTP) is an effective remediation technology for economically developing nations. Although it's excessive organic and nutrient loads with higher water logging time triggers mixed and unprofitable microalgal mats. This may serve as a seeding source for Cyanobacterial bloom in receiving waterbodies. Since, to maintain the growth of desirable algal species in WTPs, understanding towards environmental regulation and algal mat composition is important, especially for tropical countries, like India. In this study, biological treatment pond (BTP) and outlet pond (OP), of a tannery effluent treatment plant in eastern coast of India, were chosen for surveying the algal community composition concerning ecological parameters. Nearly, both the ponds were polluted, but the diversity was lower in BTP due to its elevated nutrient content (Ammonia 173 mg L-1) and higher persistent organic matters (COD 301.7 mg L-1) than OP. Using canonical correspondence analysis, seasonal variations showed higher species abundance during early summer compared to other seasons. A total of 37 taxa forming thick algal mats were recorded. The matrix of mats was mainly composed of Cyanobacterial members such as Phormidium, Leptolyngbya, Spirulina, and Pseudanabaena, followed by diatoms, especially Amphora and Nitzschia. Diatoms commonly occurred as embedded component in the entangled matrix of blue-green algal filaments. Hierarchical cluster analysis was employed to group all these taxa based on their seasonal appearance and abundance. This year-long intensive study revealing seasonal algal mat composition patterns in these WTPs will ultimately safeguard the livelihood and security of adjoining localities through proper site-specific pollution control.

Advanced Oxidation Processes and Biotechnological Alternatives for the Treatment of Tannery Wastewater

Autor: Néstor Andrés Urbina-Suarez

Molecules. 2021

ABSTRACT

The tannery industry is one of the economic sectors that contributes to the development of different countries. Globally, Europe and Asia are the main producers of this industry, although Latin America and Africa have been growing considerably in recent years. With this growth, the negative environmental impacts towards different ecosystem resources as a result of the discharges of recalcitrated pollutants, have led to different investigations to generate alternative solutions. Worldwide, different technologies have been studied to address this problem, biological and physicochemical processes have been widely studied, presenting drawbacks with some recalcitrant compounds. This review provides a context on the different existing technologies for the treatment of tannery wastewater, analyzing the physicochemical composition of this liquid waste, the impact it generates on human health and ecosystems and the advances in the different existing technologies, focusing on advanced oxidation processes and the use of microalgae. The coupling of advanced oxidation processes with biological processes, mainly microalgae, is seen as a viable biotechnological strategy, not only for the removal of pollutants, but also to obtain value-added products with potential use in the biorefining of the biomass.

Strategy for Managing Industrial Anaerobic Sludge through the Heterotrophic Cultivation of Chlorella sorokiniana: Effect of Iron Addition on Biomass and Lipid Production

Autor: Esteban Charria-Girón

Bioengineering (Basel). 2021

ABSTRACT

Microalgae provides an alternative for the valorization of industrial by-products, in which the nutritional content varies substantially and directly affects microalgae system

performance. Herein, the heterotrophic cultivation of Chlorella sorokiniana was systematically studied, allowing us to detect a nutritional deficiency other than the carbon source through assessing the oxygen transfer rate for glucose or acetate fermentation. Consequently, a mathematical model of the iron co-limiting effect on heterotrophic microalgae was developed by exploring its ability to regulate the specific growth rate and yield. For instance, higher values of the specific growth rate (0.17 h-1) compared with those reported for the heterotrophic culture of Chlorella were obtained due to iron supplementation. Therefore, anaerobic sludge from an industrial wastewater treatment plant (a baker's yeast company) was pretreated to obtain an extract as a media supplement for C. sorokiniana. According to the proposed model, the sludge extract allowed us to supplement iron values close to the growth activation concentration (KFe ~12 mg L-1). Therefore, a fed-batch strategy was evaluated on nitrogen-deprived cultures supplemented with the sludge extract to promote biomass formation and fatty acid synthesis. Our findings reveal that nitrogen and iron in sludge extract can supplement heterotrophic cultures of Chlorella and provide an alternative for the valorization of industrial anaerobic sludge.

Valorization of poultry litter using Acutodesmus obliquus and its integrated application for lipids and fertilizer production

Autor: Pfano Musetsho

Sci Total Environ. 2021

ABSTRACT

Microalgae are recognized as potential candidates for resource recovery from wastewater and projected for biorefinery models. This study was undertaken to evaluate the potential of poultry litter and municipal wastewater as nutrient and water sources, for the cultivation of Acutodesmus obliquus for lipids production for biodiesel application. The efficacy of lipid extracted biomass (LEA) as fertilizer for mung bean crops was also assessed in microcosm. A. obliquus cultivation in acid pre-treated poultry litter extract (PPLE) showed maximum biomass production of 1.90 g L-1, which was 74.67% and 12.61% higher than the raw poultry litter extract (RPPE) and BG11 respectively. Higher NO3-N, NH3-N, and PO4-P removal of 79.51%, 81.82%, and 80.52% respectively were observed in PPLE as compared to RPLE treatment. The highest biomass (140.36 mg L-1 d-1), lipids (38.49 mg L-1 d-1), and carbohydrates (49.55 mg L-1 d-1) productivities were observed in the PPLE medium. The application of LEA as a fertilizer for mung bean crops showed improvement in plant growth and soil microbial activity. A maximum increase in organic carbon (59.5%) and dehydrogenase activity (130.8%) was observed in LEA amended soil which was significantly higher than chemical fertilizer (CF) control in 30 days. Whilst plant fresh weight and leaf chlorophyll in the LEA amended soil was comparable to whole algal biomass (WA) and CF control. The strategy developed could be a basis for sustainable biorefinery for the valorization of wastewater for the production of microalgae-derived biofuel and byproducts for agricultural application.

Long-term semi-continuous production of carbohydrate-enriched microalgae biomass cultivated in low-loaded domestic wastewater

Autor: Cesar E Solís-Salinas

Sci Total Environ. 2021

ABSTRACT

The production of carbohydrate-enriched biomass from waste streams as a sustainable biofuel precursor is a noteworthy endeavor. This study investigates the long-term microalgae cultivated under low domestic wastewater loads and different hydraulic retention times (HRT) in a semi-continuous photobioreactor. The influence of operational conditions, the microalgae interaction with carbon, nutrients availability, and microbial population in terms of carbohydrate content were elucidated. The results revealed that the

operation at similar low nutrients and carbon loads maintained at three different hydraulic retention times (HRT) of 10, 8, and 6 days caused different patterns in nutrients uptake and biomass composition. Particularly, the carbohydrate accumulation was greatly influenced by the unbalance in the N:P ratios than complete depletion of the nutrients. Hence, during the period operated at HRT of 10 d, high nutrients removal efficiencies were observed while gradually increasing carbohydrate content up to 57% in dry cell weight (DCW). Afterward, the decrease to 8 and 6 d of HRT showed lower nutrient consumption with depleted alkalinity, reaching an appreciably high carbohydrate accumulation of up to 46%, and 56%, respectively. The biomass concentration decreased in the order of HRT of 10, 8, and 6 days. This study demonstrated that microalgae adapted to low carbon and nutrient loads could still accumulate high carbohydrate at shorter HRT using domestic wastewater as substrate.

Microalgae cultivation in wastewater from agricultural industries to benefit next generation of bioremediation: a bibliometric analysis

Autor: Jessica Muniz Melo

Environ Sci Pollut Res Int. 2022

ABSTRACT

The aim of this study was to provide a bibliometric analysis and mapping of existing scientific papers, focusing on microalgae cultivation coupled with biomass production and bioremediation of wastewater from agricultural industries, including cassava, dairy, and coffee. Using the Web of Science (WoS) database for the period 1996-2021, a search was performed using a keyword strategy, aiming at segregating the papers in groups. For the first search step, the keywords "wastewater treatment", AND "microalgae", AND "cassava" OR "dairy" OR "coffee" were used, resulting in 59 papers. For the second step, the keywords "wastewater treatment" AND "biomass productivity" AND "microalgae" AND "economic viability" OR "environmental impacts" were used, which resulted in 34 articles. In these papers, keywords such as "carbon dioxide biofixation" and "removal of nutrients by the production of biomass by microalgae" followed by "environmental and economic impacts" were highlighted. Some of these papers presented an analysis of the economic feasibility of the process, which reveal the state-of-the-art setup required to make the cultivation of microalgae economically viable. Researches focusing on the efficiency of microalgae biomass harvesting are needed to improve the integration of microalgae production in industrial eco-parks using wastewater to achieve the global goal of bioremediation and clean alternatives for renewable energy generation.

Improving reverse osmosis concentrate treatment and nutrients conversion to Chlorella vulgaris bioenergy assisted with granular activated carbon

Autor: Rui Hu

Sci Total Environ. 2022

ABSTRACT

Landfill leachate (LL), especially the reverse osmosis concentrate (ROC), is a societal burden due to high toxicity but may have intrinsic values attributing to copious nutrients and organics. ROC bioremediation by microalgae has attracted much attentions benefiting from its extra advantage of bioenergy production. However, efficient microalgae cultivation with ROC is still a challenging task attributing to notorious ROC characteristics, like high chromaticity and toxicity. To alleviate these negative influences, a technique integrating granular activated carbon (GAC) pretreatment and microalgae bioremediation was proposed, with which nitrogen and phosphorus removal efficiencies achieved 100% along with an optimized microalgal biomass concentration of 1.44 g/L and lipid yield of 482.4 mg/L. Furthermore, a total volumetric energy yield of 33.6 kJ/L was acquired, which was conducive to realize energy valorization. The visualization evidence of three-dimensional

fluorescence spectroscopy revealed chromaticity degradation mechanism of ROC as humic acids reduction and transfer to family of soluble microbial by-products. Meanwhile, contributions of GAC adsorption and microalgae assimilation on nutrients removal were analyzed. Together, this work provides a promising method and valuable information for ROC bioremediation with microalgae.

Formulation of New Media from Dairy and Brewery Wastes for a Sustainable Production of DHA-Rich Oil by Aurantiochytrium mangrovei

Autor: Giovanni L Russo

Mar Drugs. 2021

ABSTRACT

Mozzarella stretching water (MSW) is a dairy effluent generated from mozzarella cheese production that does not have a real use and is destined to disposal, causing environmental problems and representing a high disposal cost for dairy producers. Spent brewery yeast (SBY) is another promising food waste produced after brewery manufacturing that could be recycled in new biotechnological processes. Aurantiochytrium mangrovei is an aquatic protist known as producer of bioactive lipids such as omega 3 long chain polyunsaturated fatty acids (ω3 LC-PUFA), in particular docosahexaenoic acid (DHA). In this work MSW and SBY have been used to formulate new sustainable growth media for A. mangrovei cultivation and production of DHA in an attempt to valorize these effluents. MSW required an enzymatic hydrolysis to enhance the biomass production. The new media obtained from hydrolysed MSW was also optimized using response surface methodologies, obtaining 10.14 g L-1 of biomass in optimized medium, with a DHA content of 1.21 g L-1.

Reduction and liquid-solid partitioning of SARS-CoV-2 and adenovirus throughout the different stages of a pilot-scale wastewater treatment plant

Autor: Maria Fernanda Espinosa

Water Res. 2022

ABSTRACT

Investigating waterborne viruses is of great importance to minimizing risks to public health. Viruses tend to adsorb to sludge particles from wastewater processes by electrostatic and hydrophobic interactions between virus, aquatic matrix, and particle surface. Sludge is often re-used in agriculture; therefore, its evaluation is also of great interest to public health. In the present study, a pilot scale system treating real domestic wastewater from a large city in Brazil was used to evaluate the removal, the overall reduction, and liquid-solid partitioning of human adenovirus (HAdV), the novel coronavirus (SARS-CoV-2) and fecal indicators (F-specific coliphages and E. coli). The system consists of a high-rate algal pond (HRAP) post-treating the effluent of an upflow anaerobic sludge blanket (UASB) reactor. Samples were collected from the influent and effluent of each unit, as well as from the sludge of the UASB and from the microalgae biomass in the HRAP. Pathogens and indicators were quantified by quantitative polymerase chain reaction (qPCR) (for HAdV), qPCR with reverse transcription (RTqPCR) (for SARS-CoV-2), the double agar plaque assay (for coliphages), and the most probable number (MPN) method (for E. coli). The removal and overall reduction of HAdV and SARS-CoV-2 was greater than 1-log10. Almost 60% of remaining SARS-CoV-2 RNA and more than 70% of remaining HAdV DNA left the system in the sludge, demonstrating that both viruses may have affinity for solids. Coliphages showed a much lower affinity to solids, with only 3.7% leaving the system in the sludge. The system performed well in terms of the removal of organic matter and ammoniacal nitrogen, however tertiary treatment would be necessary to provide further pathogen reduction, if the effluent is to be reused in agriculture. To our knowledge, this is the first study that evaluated the reduction and partitioning of SARS-CoV-2 and HAdV through the complete cycle of a wastewater treatment system consisting of a UASB reactor followed by HRAPs.

Production of microalgae with high lipid content and their potential as sources of nutraceuticals

Autor: Aswathy Udayan

Phytochem Rev. 2022

ABSTRACT

In the current global scenario, the world is under a serious dilemma due to the increasing human population, industrialization, and urbanization. The ever-increasing need for fuels and increasing nutritional problems have made a serious concern on the demand for nutrients and renewable and eco-friendly fuel sources. Currently, the use of fossil fuels is creating ecological and economic problems. Microalgae have been considered as a promising candidate for high-value metabolites and alternative renewable energy sources. Microalgae offer several advantages such as rapid growth rate, efficient land utilization, carbon dioxide sequestration, ability to cultivate in wastewater, and most importantly, they do not participate in the food crop versus energy crop dilemma or debate. An efficient microalgal biorefinery system for the production of lipids and subsequent byproduct for nutraceutical applications could well satisfy the need. But, the current microalgal cultivation systems for the production of lipids and nutraceuticals do not offer techno-economic feasibility together with energy and environmental sustainability. This review article has its main focus on the production of lipids and nutraceuticals from microalgae, covering the current strategies used for lipid production and the major high-value metabolites from microalgae and their nutraceutical importance. This review also provides insights on the future strategies for enhanced microalgal lipid production and subsequent utilization of microalgal biomass.

Influence of the hydraulic retention time on the removal of emerging contaminants in an anoxic-aerobic algal-bacterial photobioreactor coupled with anaerobic digestion

Autor: Graziele Ruas

Sci Total Environ. 2022

ABSTRACT

This work evaluated, for the first time, the performance of an integral microalgae-based domestic wastewater treatment system composed of an anoxic reactor and an aerobic photobioreactor, coupled with an anaerobic digester for converting the produced algal-bacterial biomass into biogas, with regards to the removal of 16 contaminants of emerging concern (CECs): penicillin G, tetracycline, enrofloxacin, ciprofloxacin, sulfamethoxazole, tylosin, trimethoprim, dexamethasone, ibuprofen, naproxen, acetaminophen, diclofenac, progesterone, carbamazepine, triclosan and propylparaben. The influence of the hydraulic retention time (HRT) in the anoxic-aerobic bioreactors (4 and 2.5 days) and in the anaerobic digester (30 and 10 days) on the fate of these CECs was investigated. The most biodegradable contaminants (removal efficiency >80% regardless of HRT) were tetracycline, ciprofloxacin, sulfamethoxazole, tylosin, trimethoprim, dexamethasone, ibuprofen, naproxen, acetaminophen and propylparaben (degraded predominantly in the anoxic-aerobic bioreactors), and tetracycline, sulfamethoxazole, tylosin, trimethoprim and naproxen (degraded predominantly in the anaerobic reactor). The anoxic-aerobic bioreactors provided removal of at least 48% for all CECs tested. The most recalcitrant contaminants in the anaerobic reactor, which were not removed at any of the HRT tested, were enrofloxacin, ciprofloxacin, progesterone and propylparaben.

An overview of microalgae biomass as a sustainable aquaculture feed ingredient: food security and circular economy

Autor: Ashfaq Ahmad

Bioengineered. 2022

ABSTRACT

Sustainable management of natural resources is critical to food security. The shrimp feed and fishery sector is expanding rapidly, necessitating the development of alternative sustainable components. Several factors necessitate the exploration of a new source of environmentally friendly and nutrient-rich fish feed ingredients. Microalgal biomass has the potential to support the growth of fish and shrimp aquaculture for global food security in the bio-economy. Algal biorefineries must valorize the whole crop to develop a viable microalgae-based economy. Microalgae have the potential to replace fish meal and fish oil in aquaculture and ensure sustainability standards. Microalgae biomasses provide essential amino acids, valuable triglycerides such as lipids, vitamins, and pigments, making them suitable as nutritional supplements in livestock feed formulations. Fish and microalgae have similar nutritional profiles, and digestibility is a critical aspect of the aquafeed formulation. A highly digestible feed reduces production costs, feed waste, and the risk of eutrophication. Due to low input costs, low carbon footprint, wastewater treatment benefits, and carbon credits from industrial CO2 conversion, microalgae-based fish and shrimp feeds have the potential to provide significant economic benefits. However, several challenges must be addressed before microalgal biomass and bioproducts may be used as fish feeds, including heavy metal bioaccumulation, poor algal biomass digestion, and antinutrient effects. Knowledge of biochemical composition is limited and diverse, and information on nutritional value is scattered or contradictory. This review article presents alternative approaches that could be used in aquaculture to make microalgal biomass a viable alternative to fish meal.

Anaerobic digestion challenges and resource recovery opportunities from land-based aquaculture waste and seafood processing byproducts: A review

Autor: Abhinav Choudhury

Bioresour Technol. 2022

ABSTRACT

The unprecedented demand for seafood has resulted in land-based recirculating aquaculture systems (RAS), a highly intensive but sustainable fish farming method. However, intensification also results in concentrated waste streams of fecal matter and uneaten feed. Harvesting and processing vast quantities of fish also leads to the production of byproducts, further creating disposal challenges for fish farms. Recent research indicates that anaerobic digestion (AD), often used for waste treatment in agricultural and wastewater industries, may provide a viable solution. Limited research on AD of freshwater, brackish, and saline wastewater from RAS facilities and co-digestion of seafood byproducts has shown promising results but with considerable operational and process stability issues. This review discusses challenges to AD due to low solid concentrations, salinity, low carbon/nitrogen ratio, and high lipid content in the waste streams. Opportunities for recovering valuable biomolecules and nutrients through microbial treatment, aquaponics, microalgae, and polyhydroxyalkanoate production are also discussed.

Sustainable microalgal biomass production in food industry wastewater for low-cost biorefinery products: a review

Autor: Sabeela Beevi Ummalyma

Phytochem Rev.

ABSTRACT

Microalgae are recognized as cell factories enriched with biochemicals suitable as feedstock for bio-energy, food, feed, pharmaceuticals, and nutraceuticals applications. The industrial application of microalgae is challenging due to hurdles associated with mass cultivation and biomass recovery. The scale-up production of microalgal biomass in freshwater is not a sustainable solution due to the projected increase of freshwater demands in the coming years. Microalgae cultivation in wastewater is encouraged in recent years for sustainable bioeconomy from biorefinery processes. Wastewater from the food industry is a less-toxic growth medium for microalgal biomass production. Traditional wastewater treatment and management processes are expensive; hence it is highly relevant to use low-cost wastewater treatment processes with revenue generation through different products. Microalgae are accepted as potential biocatalysts for the bioremediation of wastewater. Microalgae based purification of wastewater technology could be a universal alternative solution for the recovery of resources from wastewater for low-cost biomass feedstock for industry. This review highlights the importance of microalgal biomass production in food processing wastewater, their characteristics, and different microalgal cultivation methods, followed by nutrient absorption mechanisms. Towards the end of the review, different microalgae biomass harvesting processes with biorefinery products, and void gaps that tend to hinder the biomass production with future perspectives will be intended. Thus, the review could claim to be valuable for sustainable microalgae biomass production for eco-friendly bioproduct conversions.

Artificial neural network-based estimation of COVID-19 case numbers and effective reproduction rate using wastewater-based epidemiology

Autor: Guangming Jiang

Water Res. 2022

ABSTRACT

As a cost-effective and objective population-wide surveillance tool, wastewater-based epidemiology (WBE) has been widely implemented worldwide to monitor the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) RNA concentration in wastewater. However, viral concentrations or loads in wastewater often correlate poorly with clinical case numbers. To date, there is no reliable method to back-estimate the coronavirus disease 2019 (COVID-19) case numbers from SARS-CoV-2 concentrations in wastewater. This greatly limits WBE in achieving its full potential in monitoring the unfolding pandemic. The exponentially growing SARS-CoV-2 WBE dataset, on the other hand, offers an opportunity to develop data-driven models for the estimation of COVID-19 case numbers (both incidence and prevalence) and transmission dynamics (effective reproduction rate). This study developed artificial neural network (ANN) models by innovatively expanding a conventional WBE dataset to include catchment, weather, clinical testing coverage and vaccination rate. The ANN models were trained and evaluated with a comprehensive state-wide wastewater monitoring dataset from Utah, USA during May 2020 to December 2021. In diverse sewer catchments, ANN models were found to accurately estimate the COVID-19 prevalence and incidence rates, with excellent precision for prevalence rates. Also, an ANN model was developed to estimate the effective reproduction number from both wastewater data and other pertinent factors affecting viral transmission and pandemic dynamics. The established ANN model was successfully validated for its transferability to other states or countries using the WBE dataset from Wisconsin, USA.

Fluoxetine and Nutrients Removal from Aqueous Solutions by phycoremediation

Autor: Andreia D M Silva

Int J Environ Res Public Health. 2022

ABSTRACT

The tertiary treatment using microalgae offers an attractive alternative to the removal of low but relevant concentrations of pharmaceuticals from domestic wastewaters. The removal of fluoxetine from aqueous solutions by living and non-living (lyophilized) Chlorella vulgaris was assessed. The determination of the pH at the point of zero charge, Fourier transmittance infrared analysis, and scanning electron microscopy were performed to characterize the microalgae biomass. Kinetic and equilibrium experiments were performed. The pseudo-second-order model described the kinetics of fluoxetine. The corresponding kinetic constants indicated that biosorption was faster onto non-living biomass than onto living biomass. The equilibrium results showed that the systems followed the Langmuir isotherm model. The maximum capacity of living microalgae (1.9 ± 0.1 mg·g-1) was slightly higher than the non-living microalgae (1.6 ± 0.2 mg·g-1). Living Chlorella vulgaris, free and immobilized in calcium-alginate, were also used to remove fluoxetine and nutrients (nitrogen and phosphorus) from treated municipal wastewater in a batch system. In both experiments, fluoxetine was completely removed within six days. The total phosphorus (TP) and total nitrogen (TN) removal efficiencies achieved for free and immobilized cells were, null and 65.0 ± 0.1%, and 86.2 ± 0.1% and 81.8 ± 3.1, respectively.

A waste-to-wealth initiative exploiting the potential of Anabaena variabilis for designing an integrated biorefinery

Autor: Dipanwita Deb

Sci Rep. 2022

ABSTRACT

The current research work was an innovative approach providing dual advantages of waste bioremediation and an effective biorefinery. The study attempted to exploit wastewater like aqua discharge and solid wastes like poultry litter/cow dung for cyanobacterial cultivation. Aqua discharge appended with 7.5 g L-1 poultry litter turned out as the best combination generating 46% higher carbohydrate yield than BG-11 control. A. variabilis cultivation in this waste-utilized medium also revealed its excellent bioremediation ability. While 100% removal was observed for nitrite, nitrate, and orthophosphate, a respective 74% and 81% reduction was noted for ammonium and total organic carbon. Chemical and biological oxygen demands were also reduced by 90%. This work was also novel in developing a sequential design for the production of bioethanol and co-products like exopolysaccharides, sodium copper chlorophyllin, C-phycocyanin, and poly-β-hydroxybutyrate from the same cyanobacterial biomass. The developed biorefinery implementing the waste-utilized medium was one of its kind, enabling biomass valorization of 61%. Therefore, the present study would provide a leading-edge for tackling the high production costs that limit the practical viability of biorefinery projects. The recyclability of the bioremediated wastewater would not only curtail freshwater usage, the waste disposal concerns would also be mitigated to a great extent.

Comparative life cycle assessment of conventional and novel microalgae production systems and environmental impact mitigation in urban-industrial symbiosis

Autor: Joseph Santhi Pechsiri

Sci Total Environ. 2022

ABSTRACT

The versatility of microalgae biomass as candidates for various products and bioremediation needs motivates interests towards design and implementation of novel

microalgae bioreactors. Conventional open-reactors are reliant on large quantities of sunlight and space while yields are constrained by outdoor environment conditions. Conversely, closed-reactor systems like bubble columns reduces these constrains on microalgae growth while occupying far less space at the expense of high energy demands, notably from lighting systems. A novel patented closed reactor design has recently been proposed that improves the bubble column concept with an efficient and effective lighting system. The present study uses Life Cycle Assessment approach to compare the environmental performance of conventional reactors and the proposed internally luminated novel closed reactor design, expressing impacts per kg biostimulant for the Scenedesmus almeriensis harvest from such units. All performance data was collected from a pilot facility in Almeria, Spain. Urban-industrial symbiosis scenarios are also portrayed in the study using wastewater and incinerator flue gas. Results show that under synthetic nutrient and carbon inputs in Spanish pilot operations, the cumulative energy demand for the novel photobioreactors is similar to conventional vertically-stacked horizon bioreactors but are substantially more demanding than conventional open reactors. However, when leveraging renewable energy sources and the photosynthesis process to consume wastestreams in urban-industrial symbiosis scenarios, the novel photobioreactor was able to achieve up to 80 % improvements in several impact categories e.g. eutrophication and climate change. Impact mitigation credits per kg dwt biomass across all energy scenarios in symbiosis amount to ≈1.8 kg CO2eq and ≈0.09 kg PO4 eq. This highlights that such closed and internally illuminated photobioreactors can be competitive with conventional reactors, and have potential to harness photosynthesis to reduce environmental burdens in an urban-industrial symbiosis setting. Possible economies of scale and the associated potential gains in efficiencies are further discussed.

Microalgae-based wastewater treatment for developing economic and environmental sustainability: Current status and future prospects

Autor: Piroonporn Srimongkol

Front Bioeng Biotechnol. 2022

ABSTRACT

Over the last several decades, concerns about climate change and pollution due to human activity has gained widespread attention. Microalgae have been proposed as a suitable biological platform to reduce carbon dioxide, a major greenhouse gas, while also creating commercial sources of high-value compounds such as medicines, cosmetics, food, feed, and biofuel. Industrialization of microalgae culture and valorization is still limited by significant challenges in scaling up the production processes due to economic constraints and productivity capacities. Therefore, a boost in resource usage efficiency is required. This enhancement not only lowers manufacturing costs but also enhancing the long-term viability of microalgae-based products. Using wastewater as a nutrient source is a great way to reduce manufacturing costs. Furthermore, water scarcity is one of the most important global challenges. In recent decades, industrialization, globalization, and population growth have all impacted freshwater resources. Moreover, high amounts of organic and inorganic toxins in the water due to the disposal of waste into rivers can have severe impacts on human and animal health. Microalgae cultures are a sustainable solution to tertiary and quaternary treatments since they have the ability to digest complex contaminants. This review presents biorefineries based on microalgae from all angles, including the potential for environmental pollution remediation as well as applications for bioenergy and value-added biomolecule production. An overview of current information about microalgae-based technology and a discussion of the associated hazards and opportunities for the bioeconomy are highlighted.

Cultivating photosynthetic microorganisms in cooling water waste and urban effluents as a strategy of water regeneration and valorization

Autor: Edwin Ortíz-Sánchez

Environ Technol. 2022

ABSTRACT

Contaminants from cooling water waste (CWW) generated by industries represent an environmental hazard if discharged into aquatic bodies and soil without treatment. Most treatment strategies are energy-demanding and costly; hence, low-cost and sustainable treatment alternative technologies are needed. The present study proposed cyanobacteria culture as a low-cost biological method to treat cooling water waste (CWW) while simultaneously producing carbohydrates. For this purpose, CWW from a cooling tower was evaluated in different dilutions with domestic wastewater (DW) (DW25% -CWW75%, DW50% -CWW50%, DW25% -CWW75%, DW100%, and CWW100%) (v/v). The CWW provided a high content of inorganic carbon and low content of N and P, which resulted in a high C/N ratio promoting a fast carbohydrate accumulation but low biomass production. In contrast, cultures with higher DW concentrations achieved similar results in 14 days. The best results were obtained with DW25% -CWW75%, achieving up to 52 ± 18% carbohydrate content on day 8, with the highest biomass concentration of 1.7 ± 0.12 g L-1 on day 14. This culture removed >94% of TAN, N-NO3- and P-PO43-, and 84 ± 10.82% of COD. This strategy could be a promising approach to treating CWW and DW from the same industry and producing value-added products and bioenergy.

Nutrient Removal and Membrane Performance of an Algae Membrane Photobioreactor in Urban Wastewater Regeneration

Autor: Verónica Díaz

Membranes (Basel). 2022

ABSTRACT

The increase in industry and population, together with the need for wastewater reuse, makes it necessary to implement new technologies in the circular economy framework. The aim of this research was to evaluate the quality of the effluent of an algae membrane photobioreactor for the treatment of the effluent of an urban wastewater treatment plant, to characterise the ultrafiltration membranes, to study the effectiveness of a proposed cleaning protocol, and to analyse the performance of the photobioreactor. The photobioreactor operated under two days of hydraulic retention times feed with the effluent from the Los Vados wastewater treatment plant (WWTP) (Granada, Spain). The microalgae community in the photobioreactor grew according to the pseudo-second-order model. The effluent obtained could be reused for different uses of diverse quality with the removal of total nitrogen and phosphorus of 56.3% and 64.27%, respectively. The fouling of the polyvinylidene difluoride ultrafiltration membrane after 80 days of operation was slight, increasing the total membrane resistance by approximately 22%. Moreover, the higher temperature of the medium was, the lower intrinsic resistance of the membrane. A total of 100% recovery of the membrane was obtained in the two-phase cleaning protocol, with 42% and 58%, respectively.

A review: Biological technologies for nitrogen monoxide abatement

Autor: David Cubides

Chemosphere. 2022

ABSTRACT

Nitrogen oxides (NOx), including nitrogen monoxide (NO) and nitrogen dioxide (NO2), are among the most important global atmospheric pollutants because they have a negative impact on human respiratory health, animals, and the environment through the greenhouse effect and ozone layer destruction. NOx compounds are predominantly generated by anthropogenic activities, which involve combustion processes such as energy

production, transportation, and industrial activities. The most widely used alternatives for NOx abatement on an industrial scale are selective catalytic and non-catalytic reductions; however, these alternatives have high costs when treating large air flows with low pollutant concentrations, and most of these methods generate residues that require further treatment. Therefore, biotechnologies that are normally used for wastewater treatment (based on nitrification, denitrification, anammox, microalgae, and combinations of these) are being investigated for flue gas treatment. Most of such investigations have focused on chemical absorption and biological reduction (CABR) systems using different equipment configurations, such as biofilters, rotating reactors, or membrane reactors. This review summarizes the current state of these biotechnologies available for NOx treatment, discusses and compares the use of different microorganisms, and analyzes the experimental performance of bioreactors used for NOx emission control, both at the laboratory scale and in industrial settings, to provide an overview of proven technical solutions and biotechnologies for NOx treatment. Additionally, a comparative assessment of the advantages and disadvantages is performed, and special challenges for biological technologies for NO abatement are presented.

Comparison of Growth and Chemical Profile of Diatom Skeletonema grevillei in Bioreactor and Incubation-Shaking Cabinet in Two Growth Phases

Autor: Roberta Frleta

Mar Drugs. 2022

ABSTRACT

Marine microalgae, diatoms, are considered a source of a wide range of high-value compounds, and numerous studies indicate their biotechnological potential in the food and feed industry, cosmetic industry, nanotechnology, pharmaceutical industry, biodiesel production, fertilizers, and wastewater treatment. The aim of this study was to compare the growth, chemical profiles, and antioxidant activity of the diatom Skeletonema grevillei cultivated in a bioreactor and an incubation-shaking cabinet at different growth phases (after 192 and 312 h). Growth was monitored by evaluating cell density with the Sedgewick Rafter chamber, and the collected biomass was extracted with 70% ethanol assisted by ultrasound. Extracts were evaporated to dryness and compounds were identified in derivatized form by gas chromatography and mass spectrometry (GC-MS) analysis, while antioxidant capacity was evaluated by DPPH and ORAC. Significantly faster growth was observed in the bioreactor than in the incubation-shaking cabinet. Oleamide, palmitelaidic acid, glycerol monostearate, myristic acid, cholesterol, eicosapentaenoic acid, 1-monopalmitin, and 24-methylene cholesterol were identified as the major compounds in both systems. Among them, oleamide was the dominant compound in both systems. It is also shown that prolonging the cultivation period had a direct effect on increasing the extract yield. The highest DPPH inhibition (11.4 ± 1%) and ORAC values (93.3 ± 8.4 mM TE) were obtained for the S. grevillei extract recovered from the bioreactor after 312 h. The obtained results contribute to the possibility of using S. grevillei for various biotechnological applications in the future.

Effect of biomass retention time on performance and fouling of a stirred membrane photobioreactor

Autor: Bao-Trong Dang

Sci Total Environ. 2022

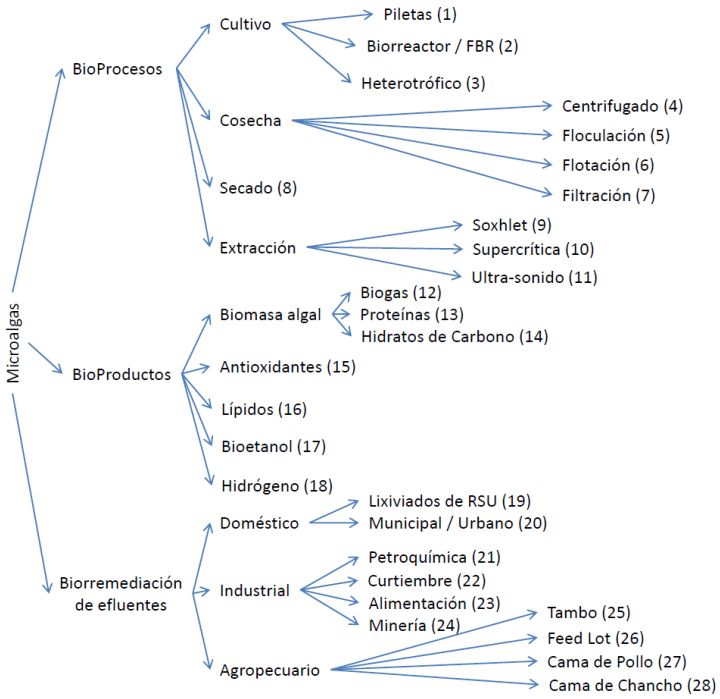
ABSTRACT

Co-culture of microalgae-activated sludge has the potential to purify wastewater while reduce energy demand from aeration. In this work, a mechanically stirred membrane photobioreactor (stirred-MPBR) was used to evaluate the impact of the biomass retention time (BRT) on the treatment performance and membrane fouling. Results showed that stirred-MPBR was affected by BRT during treating domestic wastewater at a flux of 16.5 L

m-2 h-1. The highest productivity was attained at BRT 7d (102 mg L-1 d-1), followed by BRT 10d (86 mg L-1 d-1), BRT 5d (85 mg L-1 d-1), and BRT 3d (83 mg L-1 d-1). Statistical analysis results showed that BRT 7d had a higher COD removal rate than BRT 10d, however, there is no difference in total nitrogen removal rate. The highest TP removal occurred when the biomass operated at BRT as short as 3d. Reduced BRTs caused a change in the microalgae-activated sludge biomass fraction that encouraged nitrification activity while simultaneously contributing to a higher fouling rate. The bound protein concentrations dropped from 31.35 mg L-1 (BRT 10d) to 10.67 mg L-1 (BRT 3d), while soluble polysaccharides increased from 0.99 to 1.82 mg L-1, respectively. The concentrations of extracellular polymeric substance fractions were significantly altered, which decreased the mean floc size and contributed to the escalating fouling propensity. At the optimum BRT of 7d, the stirred-MPBR showed sufficient access to light and nutrients exchange for mutualistic interactions between the microalgae and activated sludge.

Árbol de categorías

Español



Inglés