UNIDAD DE VIGILANCIA TECNOLÓGICA E INTELIGENCIA COMPETITIVA

Microalgas

Diciembre 2016

Ministerio de Agroindustria
Presidencia de la Nación

Participan en Confección y Edición
Juan Ignacio Gori
Fernando Carlos Zelaschi

Contenido

En este boletín se presentan las publicaciones, patentes y noticias de interés de los últimos meses del 2016. Asimismo se listan eventos que tendrán lugar en el transcurso del año 2017.

En los sucesivos boletines se presentarán las novedades de la tecnología del cultivo de microalgas enmarcadas en tres grandes rubros (Bioprocesos, Bioproductos y Bioremediación).

Para acceder a el vínculo de cada publicación hacer control + clic en el título deseado.

BIOPROCESOS

PUBLICACIONES

Light enhanced the accumulation of total fatty acids (TFA) and docosahexaenoic acid (DHA) in a newly isolated heterotrophic microalga Crypthecodinium sp. SUN

Fecha de Publicación: Marzo 2017
Fuente: Bioresource Technology, Volume 228
Autores: Dongzhe Sun, Zhao Zhang, Xuemei Mao, Tao Wu, Yue Jiang, Jin Liu, Feng Chen
Abstract

In the present study, light illumination was found to be efficient in elevating the total fatty acid content in a newly isolated heterotrophic microalga, Crypthecodinium sp. SUN. Under light illumination, the highest total fatty acid and DHA contents were achieved at 96h as 24.9% of dry weight and 82.8mgg^{-1} dry weight, respectively, which were equivalent to 1.46-fold and 1.68-fold of those under the dark conditions. The elevation of total fatty acid content was mainly contributed by an increase of neutral lipids at the expense of starches. Moreover, light was found to alter the cell metabolism and led to a higher specific growth rate, higher glucose consumption rate and lower non-motile cell percentage. This is the first report that light can promote the total fatty acids accumulation in Crypthecodinium without growth inhibition.

Nutrient recycle from defatted microalgae (Aurantiochytrium) with hydrothermal treatment for microalgae cultivation

Fecha de Publicación: Marzo 2017
Fuente: Bioresource Technology, Volume 228
Autores: Taku Michael Aida, Ryouma Maruta, Yuuhiko Tanabe, Minori Oshima, Toshiyuki Nonaka, Hiroki Kujiraoka, Yasuaki Kumagai, Masaki Ota, Iwane Suzuki, Makoto M. Watanabe, Hiroshi Inomata, Richard L. Smith

Abstract

Defatted heterotrophic microalgae (Aurantiochytrium limacinum SR21) was treated with high temperature water (175–350°C, 10–90min) to obtain nitrogen and phosphorous nutrients as a water soluble fraction (WS). Yields of nitrogen and phosphorous recovered in WS varied from 38 to 100% and from 57 to 99%, respectively. Maximum yields of nitrogen containing compounds in WS were proteins (43%), amino acids (12%) and ammonia (60%) at treatment temperatures of 175, 250 and 350°C, respectively. Maximum yield of phosphorous in WS was 99% at a treatment temperature of 250°C. Cultivation experiments of microalgae (A. limacinum SR21) using WS obtained at 200 and 250°C showed positive growth. Water soluble fractions from hydrothermal treatment of defatted microalgae are effective nitrogen and phosphorous nutrient sources for microalgae cultivation.

Graphical abstract

Detoxification of ammonium to Nannochloropsis oculata and enhancement of lipid production by mixotrophic growth with acetate

Fecha de Publicación: Marzo 2017
Fuente: Bioresource Technology, Volume 227
Autores: Weitie Lin, Pengfei Li, Zipeng Liao, Jianfei Luo

Abstract

In this study, the toxicity of ammonium was removed in the microalga Nannochloropsis oculata by using acetate as a carbon source. Algal biomass and lipid production were significantly enhanced when N. oculata was grew on 0.5–50mM of ammonium and 16–64mM of acetate in mixotrophic conditions. When grown mixotrophically on 1mM of ammonium and 32mM of acetate, the biomass and lipid production reached 543mg/L and 279mg/L respectively, which were 1.5 and 9.4times higher than the levels generated when grown autotrophically on nitrate. This suggests that mixotrophic growth with acetate can be a useful method to enhance microalgal lipid production.

Waste-free technology of wastewater treatment to obtain microalgal biomass for biodiesel production

Fecha de Publicación: Disponible online 3 Enero 2017
Fuente: International Journal of Hydrogen Energy
Autores: Bolatkhan K. Zayadan, Asemgul K. Sadvakasova, Aizhan A. Usserbayeva, Kenzhegul Bolatkhan, Aizhan M. Baizhigitova, Nurziya R. Akmukhanova, Roman A. Sidorov, Maria A. Sinetova, Dmitry A. Los

Abstract

Five axenic cultures of microalgae were isolated from the wastewater of Almaty city and identified as Chlorella vulgaris strain № 1, Chlorella sp. strain № 3, Scenedesmus obliquus, Phormidium foveolarum and Lyngbya limnetica. Among these strains, C. vulgaris strain № 1 was characterized by the maximum growth rate and the highest productivity. Mass cultivation of this strain in wastewater resulted in accumulation of 5×10^7 cells per ml in 16 days, and in the removal of ~95% of pollutants from water. Cells of C. vulgaris consisted of ~35% proteins, 29% carbohydrates, 30% lipids, and 6% ash, as calculated on a dry weight basis. The major fatty-acids of C. vulgaris were represented by palmitic, cis-7,10-hexadecenoic acid, linoleic, and α-linolenic acids. Culturing in wastewater decreased the unsaturation index of FAs. Thus, C. vulgaris cells are suitable for both waste water purification and accumulation of biomass for further biodiesel production.

Fecha de Publicación:
Fuente:
Autores:
Abtract

Production of liquid biofuels (biodiesel and bioethanol) from brown marine macroalgae Padina tetrastromatica

Fecha de Publicación: 1 Marzo 2017
Fuente: Energy Conversion and Management, Volume 135
Autores: Veeramuthu Ashokkumar, Mohd Razman Salim, Zainal Salam, Pandian Sivakumar, Cheng Tung Chong, Sanniyasi Elumalai, Veeraperumal Suresh, Farid Nasir Ani

Abstract

In this study, an integrated biomass conversion concept of producing liquid biofuels from brown marine macroalga Padina tetrastromatica was investigated. The algal biomass was collected from the Mandapam coastal region and processed under laboratory. Various parameters were studied to extract crude lipids from the biomass. A kinetic study was conducted for extracting the lipids from the biomass, which follows the first order kinetics and the lipid yield was 8.15wt.%. The activation energy; Ea=34.314kJmol^{-1} and their thermodynamic parameters were determined. Since the crude algal lipids contain high amount of free fatty acids, a sequential transesterification technique was examined and 7.8% of biodiesel (78mg/g algal biomass) yield was obtained. The biodiesel was analyzed by ^{1}H and ^{13}C–NMR spectroscopy and the conversion yield was estimated. Further, the biodiesel fuel properties were investigated and found that all the features fit the required ASTM D6751 specification limits. The residual biomass after lipid extraction was further explored for bioethanol production through the anaerobic

fermentation process. The ethanol yield obtained after saccharification and fermentation were estimated and 161mg/g residue biomass was reported. The theoretical yield of conversion of hydrolysate to bioethanol was estimated and found to be 83.4%. Therefore, this study demonstrates that macroalga P. tetrastromatica biomass has great potential to produce liquid biofuels such as biodiesel and bioethanol.

Chemical composition and in vitro anti-algal activity of Potamogeton crispus and Myriophyllum spicatum extracts

Fecha de Publicación: Disponible online 13 Enero 2017
Fuente: The Egyptian Journal of Aquatic Research
Autores: Amany M. Haroon, Eman I. Abdel-Aal
Abtract

The aim of this work was to investigate and compare the phytochemical constituents and anti-algal activities of crude extracts from dry macrophytes species, Potamogeton crispus and Myriophyllum spicatum. Organic solvents differed in polarity including petroleum ether, methylene chloride, chloroform, acetone and methanol were used to extract the phytochemical compounds and gas chromatograph–mass spectrometry (GC–MS) analyzer was used for the detection of these compounds. Generally, the results indicated that the composition and mass fraction of phytochemical constituents varied with plant species and extraction solvents. The growth inhibition effects of separate and mixed plants extracts on Pseudokirchneriella subcapitata were studied. In addition, the effects of mixed extracts on ten taxonomically different freshwater microalgae species, using the single-species and mixed culture species tests were also studied. Among the five different extracts tested chloroform extract and mixed extracts of the two plant species showed the highest anti-algal potential with P. subcapitata. The sensitivity of microalgae species tested in single-species cultures to P. crispus and M. spicatum extracts found to be group-specific, in which cyanophyte Anabaena flos-aquae var. treleasei and the diatoms Gomphoneis eriense var. apiculate and Tryblionella hungarica were more sensitive compared to the tested green microalgae species. In addition, the inhibitory effects of macrophyte extracts decreased for the mixed microalgae cultures. The extracts of P. crispus and M. spicatum showed the presence of some bioactive compounds that could contribute toward the phyto-algicidal properties of these plants.

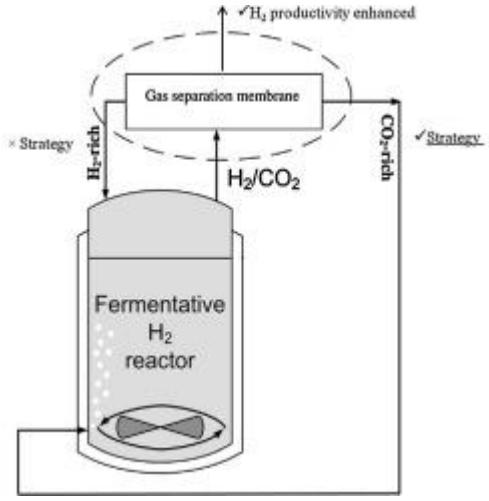
A novel gas separation integrated membrane bioreactor to evaluate the impact of self-generated biogas recycling on continuous hydrogen fermentation

Fecha de Publicación: 15 Marzo 2017
Fuente: Applied Energy, Volume 190
Autores: Péter Bakonyi, Germán Buitrón, Idania Valdez-Vazquez, Nándor Nemestóthy, Katalin Bélafi- Bakó
Abtract

A Gas Separation Membrane Bioreactor (GSMBR) by integrating membrane technology with a continuous biohydrogen fermenter was designed. The feasibility of this novel configuration for the improvement of hydrogen

production capacity was tested by stripping the fermentation liquor with CO2- and H2-enriched gases, obtained directly from the bioreactor headspace. The results indicated that sparging the bioreactor with the CO2-concentrated fraction of the membrane separation unit (consisting of two PDMS modules) enhanced the steady-state H2 productivity (8.9–9.2 L H2/L-d) compared to the membrane-less control CSTR to be characterized with 6.96–7.35 L H2/L-d values. On the other hand, purging with the H2-rich gas strongly depressed the achievable productivity (2.7–3.03 L H2/L-d). Microbial community structure and soluble metabolic products were monitored to assess the GSMBR behavior. The study demonstrated that stripping the bioH2 fermenter with its own, self-generated atmosphere after adjusting its composition (to higher CO2-content) can be a promising way to intensify dark fermentative H2 evolution.

Graphical abstract



Effective adsorption of aqueous Pb2+ by dried biomass of Landoltia punctata and Spirodela polyrhiza

Fecha de Publicación: 1 Marzo 2017
Fuente: Journal of Cleaner Production, Volume 145
Autores: Jie Tang, Yang Li, Xin Wang, Maurycy Daroch
Abtract

Lead contamination has become a serious issue and approaches are continuously searched for lead removal. Here, dried biomasses of Landoltia punctata and Spirodela polyrhiza were utilized as adsorbent for Pb^{2+} removal. Batch experiments were conducted to investigate effects of contact time, initial pH, temperature, stirring speed, adsorbent dosage, and initial Pb^{2+} concentrations on Pb^{2+} adsorption. Results showed that all these parameters had significant effect on Pb^{2+} removal efficiency of the adsorbents. Both the adsorption processes followed the pseudo-second-order kinetic model, and were well described by Langmuir isotherm. Spectroscopy analysis indicated the involvement of functional groups (–OH, C–N, C=O, N–H and C-O) in Pb^{2+} adsorption. Remarkably, the maximum Pb^{2+} adsorption capacity of L. punctata and S. polyrhiza were 250 and 200 mg g^{-1} (dry weight), respectively. Thus, it could be concluded that the

dried biomass of L. punctata and S. polyrhiza are promising adsorbents for effective lead removal.

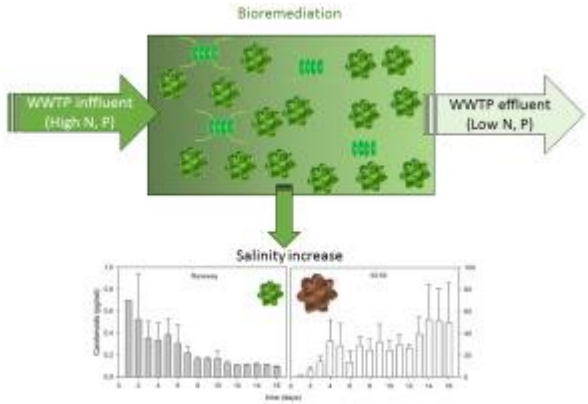
Microalgae cultivation in urban wastewater: Coelastrum cf. pseudomicroporum as a novel carotenoid source and a potential microalgae harvesting tool

Fecha de Publicación: Marzo 2017
Fuente: Bioresource Technology, Volume 228
Autores: Bárbara Úbeda, José Ángel Gálvez, Mónica Michel, Ana Bartual

Abtract

The aim of this work was to study the optimal growth and high value-added production of the microalgae Coelastrum cf. pseudomicroporum Korshikov cultivated in urban wastewater. It was observed that C. cf. pseudomicroporum grew ideally in this medium, acting as an efficient nutrient starver. Additionally, the obtained biomass increased carotenoid cell content after saltwater stress. The effects of light intensity and salt stress on its growth rate were analysed. The results showed that this alga can grow very fast using wastewater as culture medium, reaching maximum growth rates of 1.61±0.05day^{-1}, and tolerating strong irradiances. It was also found that under salt-stress this species could accumulate carotenoids (range 1.73–91.2pgcell^{-1}). Moreover, a good harvesting efficiency (96.84%) was observed using Coelastrum exudates as bioflocculant of Scenedesmus sp., so Coelastrum exudates could act as a potential bioflocculant for other species.

Graphical abstract



Microalgae growth in polluted effluents from the dairy industry for biomass production and phytoremediation

Fecha de Publicación: Febrero 2017
Fuente: Journal of Environmental Chemical Engineering, Volume 5, Issue 1

Autores: José Ignacio Labbé, Juan Luis Ramos-Suárez, Alexis Hernández-Pérez, Andrea Baeza, Felipe Hansen

Abtract

A link can be established in both the dairy and microalgae industries through the recycling of nutrients from dairy effluents (DE) in order to cultivate microalgae, using biomass on the farm or for commercial endeavors. This study assesses the development of Chlorella and Scenedesmus mixed cultures (CMC and SMC) in dairy farms using four different DE as culture media under ambient and laboratory conditions. Viability of the cultures for scaling up was determined based on biomass growth characteristics. CMC and SMC were able to grow in DE. Growth pattern was mainly affected by the type of effluent used, with almost no influence from culture conditions. CMC grew satisfactorily in effluents with high organic and ammonium loads such as cattle standing yard effluents (CSYE), reaching cell concentrations of 1.70×10^{8} and 1.67×10^{8} celml^{-1} outdoors and indoors, respectively. Contrarily, SMC grew better on effluents with high chemical and detergent loads such as milking parlor effluents (MPE), reaching cell concentrations of 3.20×10^{7} and 5.61×10^{7} celml^{-1} outdoors and indoors, respectively. Despite microalgal growth, there is a need of advance analysis for determining precisely nutrient reduction, since electrical conductivity could not be established as a remediation efficiency indicator. Overall, results show that there is a potential to treat DE through microalgae culture.

Bioprospecting for native microalgae as an alternative source of sugars for the production of bioethanol

Fecha de Publicación: Marzo 2017

Fuente: Algal Research, Volume 22

Autores: Lara Sanchez Rizza, Maria Eugenia Sanz Smachetti, Mauro Do Nascimento, Graciela Lidia Salerno, Leonardo Curatti

Abtract

While the production of biofuels holds potential to contribute to energy security, concerns on food prices, land use, and carbon emissions have arisen from increased production of first-generation bioethanol. While second-generation bioethanol from lignocellulosic agricultural waste faces difficult-to-overcome technological barriers, renewed promise is held in microalgae biomass as an alternative feedstock. In this work we show the results of bioprospecting for microalgae native of South America for accumulation of carbohydrates under conditions of nitrogen deficiency, and constant light and temperature. After a preliminary analysis of seventeen strains, we selected strain SP2-3, because its biomass could be enriched in carbohydrates over 70% (w/w) on a dry biomass basis, and Desmodesmus sp. strain FG for its fermentable sugars productivity. After optimization of microalgae culture conditions, biomass hydrolysis and fermentation with baker's yeast Saccharomyces cerevisiae, we demonstrated

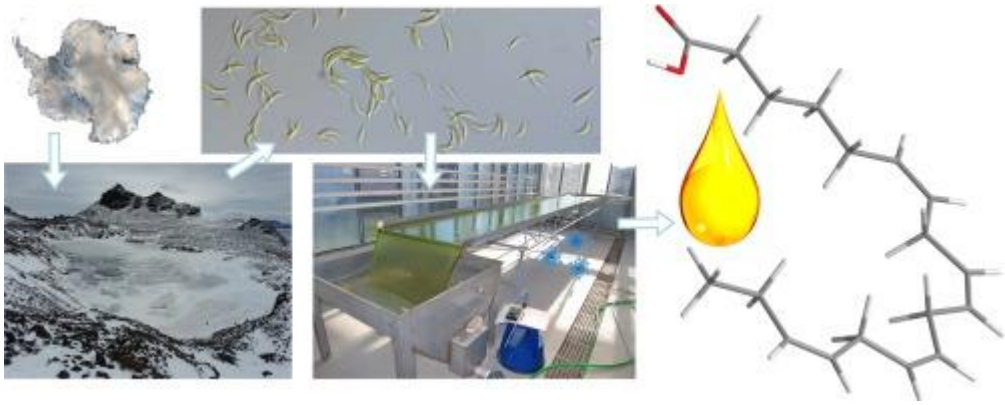
ethanol yields of up to 0.24gethanol·gofbiomass^{-1}, and an ethanol concentration in the fermentation broth of 24gethanol·Loffermentationbroth^{-1}, for up to 87.4% of the maximum theoretical value. These results contribute to support the potential of microalgae biomass as an alternative feedstock for bioethanol and the value of bioprospecting programs to identified candidate strains among natural biodiversity.

Pilot cultivation of the green alga Monoraphidium sp. producing a high content of polyunsaturated fatty acids in a low-temperature environment

Fecha de Publicación: Marzo 2017
Fuente: Algal Research, Volume 22
Autores: Tomáš Řezanka, Linda Nedbalová, Jaromír Lukavský, Antonín Střížek, Karel Sigler
Abtract

A cold-adapted strain of Monoraphidium (Selenastraceae, Chlorophyta) isolated from an Antarctic ice-covered lake was tested for polyunsaturated fatty acids (PUFAs) production. The strain was successfully cultivated in an outdoor 150L thin-layer photobioreactor under early winter conditions of Central Europe, where the average temperature was 10.0°C and the average intensity of PAR 32μmolm^{-2} s^{-1}. The growth rate over the 22days of the pilot cultivation reached a value of 0.341day^{-1} and lipid productivity was 162mgL^{-1} day^{-1}. The proportion of the 16:4 and 18:4 acids was up to 19.1% and/or 34.7% of total fatty acids that resulted in a productivity of these acids of 27.5 and 43.7mgL^{-1} day^{-1}, respectively, which is one order of magnitude higher than previously reported values. These characteristics make this strain a prospective candidate for low-temperature biotechnology.

Graphical abstract



Kinetic parameter estimation model for anaerobic co-digestion of waste activated sludge and microalgae

Fecha de Publicación: Marzo 2017
Fuente: Bioresource Technology, Volume 228
Autores: Eunyoung Lee, Jewel Cumberbatch, Meng Wang, Qiong Zhang
Abtract

Anaerobic co-digestion has a potential to improve biogas production, but limited kinetic information is available for co-digestion. This study introduced regression-based models to estimate the kinetic parameters for the co-digestion of microalgae and Waste Activated Sludge (WAS). The models were developed using the ratios of co-substrates and the kinetic parameters for the single substrate as indicators. The models were applied to the modified first-order kinetics and Monod model to determine the rate of hydrolysis and methanogenesis for the co-digestion. The results showed that the model using a hyperbola function was better for the estimation of the first-order kinetic coefficients, while the model using inverse tangent function closely estimated the Monod kinetic parameters. The models can be used for estimating kinetic parameters for not only microalgae-WAS co-digestion but also other substrates' co-digestion such as microalgae-swine manure and WAS-aquatic plants.

Microalgae cultivation in sugarcane vinasse: Selection, growth and biochemical characterization

Fecha de Publicación: Marzo 2017
Fuente: Bioresource Technology, Volume 228
Autores: Hugo Santana, Carolina R. Cereijo, Valérya C. Teles, Rodrigo C. Nascimento, Maiara S. Fernandes, Patrícia Brunale, Raquel C. Campanha, Itânia P. Soares, Flávia C.P. Silva, Priscila S. Sabaini, Félix G. Siqueira, Bruno S.A.F. Brasil
Abtract

Sugarcane ethanol is produced at large scale generating wastes that could be used for microalgae biomass production in a biorefinery strategy. In this study, forty microalgae strains were screened for growth in sugarcane vinasse at different concentrations. Two microalgae strains, Micractinium sp. Embrapa|LBA32 and C. biconvexa Embrapa|LBA40, presented vigorous growth in a light-dependent manner even in undiluted vinasse under non-axenic conditions. Microalgae strains presented higher biomass productivity in vinasse-based media compared to standard Bold's Basal Medium in cultures performed using 15L airlift flat plate photobioreactors. Chemical composition analyses showed that proteins and carbohydrates comprise the major fractions of algal biomass. Glucose was the main monosaccharide detected, ranging from 46% to 76% of the total carbohydrates content according to the strain and culture media used. This research highlights the potential of using residues derived from ethanol plants to cultivate microalgae for the production of energy and bioproducts.

Recent insights into biohydrogen production by microalgae – From biophotolysis to dark fermentation

Fecha de Publicación: Marzo 2017
Fuente: Bioresource Technology, Volume 227
Autores: Dillirani Nagarajan, Duu-Jong Lee, Akihiko Kondo, Jo-Shu Chang
Abtract

One of the best options to alleviate the problems associated with global warming and climate change is to reduce burning of fossil fuels and search for new alternative energy resources. In case of biodiesel and bioethanol production, the choice of feedstock and the process design influences the GHG emissions and appropriate methods need to be adapted. Hydrogen is a zero-carbon and energy dense alternative energy carrier with clean burning properties and biohydrogen production by microalgae can reduce production associated GHG emissions to a great extent. Biohydrogen can be produced through dark fermentation using sugars, starch, or cellulosic materials. Microalgae-based biohydrogen production is recently regarded as a promising pathway for biohydrogen production via photolysis or being a substrate for anaerobic fermentation. This review lists the methods of hydrogen production by microalgae. The enzymes involved and the factors affecting the biohydrogen production process are discussed. The bottlenecks in microalgae-based biohydrogen production are critically reviewed and future research areas in hydrogen production are presented.

Laser reflectance measurement for the online monitoring of Chlorella sorokiniana biomass concentration

Fecha de Publicación: 10 Febrero 2017
Fuente: Journal of Biotechnology, Volume 243
Autores: Patricio López Expósito, Angeles Blanco Suárez, Carlos Negro Álvarez
Abtract

Fast and reliable methods to determine biomass concentration are necessary to facilitate the large scale production of microalgae. A method for the rapid estimation of Chlorella sorokiniana biomass concentration was developed. The method translates the suspension particle size spectrum gathered though laser reflectance into biomass concentration by means of two machine learning modelling techniques. In each case, the model hyper-parameters were selected applying a simulated annealing algorithm. The results show that dry biomass concentration can be estimated with a very good accuracy (R^2 =0.87). The presented method seems to be suited to perform fast estimations of biomass concentration in suspensions of microalgae cultivated in moderately turbid media with tendency to aggregate.

Critical factors in energy generation from microalgae

Fecha de Publicación: 1 Febrero 2017
Fuente: Energy, Volume 120
Autores: Pavan Kumar Naraharisetti, Probir Das, Paul N. Sharratt

Abtract

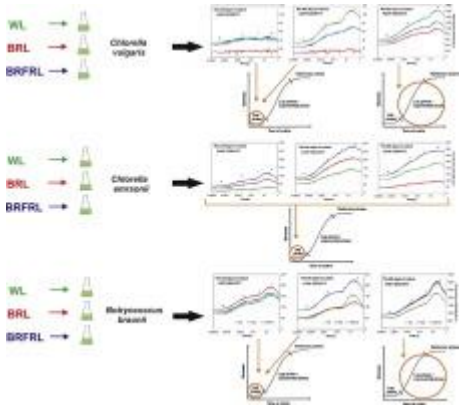
Fuels from microalgae are being considered as important alternatives to fossil fuels. In this work we have identified challenges and opportunities for research in the production of energy from microalgae. The most important challenge facing this alternative resource is the energy generation efficiency (EGE) when microalgae are used for the generation of energy. EGE is about 35% for coal fired power plants while integrated gasification fuel cell cycle (IGFC) and advanced-IGFC (A-IGFC) have an efficiency of over 50%. Other challenges include, achieving a high titer of 2 g/l, a high lipid content of up to 30% and a high CO2 mass transfer efficiency. We observed that the process of energy generation from microalgae has good positive energy balance if the EGE can be improved to greater than 50% by developing IGFC/A-IGFC technologies. Other challenges come from energy spent in dewatering, loss of energy when solvents are recycled during the process of lipid extraction, use of energy in the form of methanol and energy used in recycling excess methanol if biodiesel is produced, and energy used in the production of nutrients, among others. Hence, future research must be targeted at minimizing the energy input in these processes.

Culture density influence on the photosynthetic efficiency of microalgae growing under different spectral compositions of light

Fecha de Publicación: Febrero 2017
Fuente: Journal of Photochemistry and Photobiology B: Biology, Volume 167
Autores: M. Kula, H.M. Kalaji, A. Skoczowski
Abtract

A density in algal suspension causes a significant change in the intensity and spectral composition of light reaching individual cells. Measurements of chlorophyll fluorescence allow us to observe any general changes in the bioenergetic status of photosynthesis. The aim of the study was to determine the effect of cultivation density on the PSII photochemical efficiency of three species of algae (Chlorella vulgaris, Botryococcus braunii and Chlorella emersonii), each with a different rate of growth – high, medium and low – respectively. The cell density of algae in suspension differentiated through the cultivation time (2, 4, and 8days) and the spectral composition of light. The results showed that the density of cultivation led to change in the photosynthetic apparatus of algae. The differences described between each day of cultivation (2, 4, and 8) in the kinetics of chlorophyll a fluorescence intensity in cells of the algal strains under study probably resulted from the different phases of growth of these cultures. In addition the results showed the beneficial effect of far red light on the photosynthetic apparatus and the growth of biomass in investigated algal strains.

Graphical abstract



Porous Substrate Bioreactors: A Paradigm Shift in Microalgal Biotechnology?

Fecha de Publicación: Febrero 2017
Fuente: Trends in Biotechnology, Volume 35, Issue 2
Autores: Björn Podola, Tong Li, Michael Melkonian
Abtract

Many of the demands in the production of microalgae at a technical scale cannot presently be met by state-of-the-art cultivation technologies based on suspensions. Immobilized cultivation using porous substrate bioreactors (PSBRs) is characterized by a reduction of liquid reaction volumes by several orders of magnitude and has solved several volume-related problems. Recently, PSBRs demonstrated potential for both established and novel applications in microalgal biotechnology, and first insights into biophysical processes have provided an understanding of the benefits of PSBR biofilm cultivation. Further efforts should primarily focus on scale-up and engineering challenges in this emerging field and, additionally, provide experience in the long-term operation of bioreactors. The results may contribute to assessing the technical and economic potential of PSBR cultivation.

Mixotrophic cultivation of Chlorella for local protein production using agro-food by-products

Fecha de Publicación: Disponible online 16 Enero 2017
Fuente: Bioresource Technology
Autores: Silvia Salati, Giuliana D'Imporzano, Barbara Menin, Davide Veronesi, Barbara Scaglia, Pamela Abbruscato, Paola Mariani, Fabrizio Adani
Abtract

A local strain of Chlorella vulgaris was cultivated by using cheese whey (CW), white wine lees (WL) and glycerol (Gly), coming from local agro-industrial activities, as C sources (2.2 g C L^{-1}) to support algae production under mixotrophic conditions in Lombardy. In continuous mode, Chlorella increased biomass production compared with autotrophic conditions by 1.5-2 times, with the best results obtained for the CW substrate, i.e. 0.52 g L^{-1} d^{-1} of algal biomass vs. 0.24 g L^{-1} d^{-1} of algal biomass for autotrophic conditions, and protein content for both conditions adopted close to 500 g kg^{-1} DM. Mixotrophic conditions gave a much higher energy recovery efficiency (EF) than autotrophic conditions, i.e. organic carbon energy efficiency (EFoc) of 32% and total energy efficiency (Eft) of 8%, respectively, suggesting the potential for the culture of algae as a sustainable practice to recover efficiently waste-C and a means of local protein production.

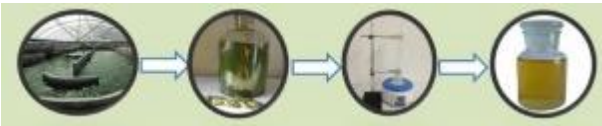
Enhanced extraction of lipids from microalgae with eco-friendly mixture of methanol and ethyl acetate for biodiesel production

Fecha de Publicación: Disponible online 16 Enero 2017
Fuente: Journal of the Taiwan Institute of Chemical Engineers
Autores: Jingcheng Wu, Md. Asraful Alam, Ying Pan, Dalong Huang, Zhongming Wang, Tiejun Wang

Abtract

Developing technologies for the production of biofuel from renewable resources is a field of interest for many researchers. Lipid extraction could be an important step in the microalgae biodiesel production process. Factors affecting intracellular lipid extraction from Chlorella sp. cultivated in outdoor raceway ponds were investigated; an optimized procedure for extraction of total and non-polar lipids using eco-friendly solvent combination of ethyl acetate and methanol was proposed. The effects of solvent, and extraction variables (temperature, time, ratio of solvent and biomass, ratio of ethyl acetate and methanol) on total lipid content, and lipid class were examined via single-factor experiments coupled with response surface methodology (RSM) using Box–Behnken design (BBD). The results revealed that the maximum lipid extraction yield was 18.1% obtained after extraction 120min, extraction temperature 60°C and M/EA ratio was 2:1. Fatty acid profiles of lipid were determined; palmitic acid (C16:0), palmitoleic (C16:1) oleic acid (C18:1), linoleic acid (C18:2) and linolenic acid (C18:3) are the most abundant fatty acids, indicating the great capacity of lipid extraction from microalgae for biodiesel production.

Graphical abstract



Optimal Dynamic Operation of Microalgae Cultivation Coupled with Recovery of Flue Gas CO2 and Waste Heat

Fecha de Publicación: Disponible online 10 Enero 2017
Fuente: Computers & Chemical Engineering
Autores: Abdulla Malek, Nahla Alamoodi, Ali S. Almansoori, Prodromos Daoutidis
Abtract

This work addresses integration of microalgae cultivation with power production for the recovery of flue gas waste heat and CO2. The economics of supplying CO2 to an outdoor open pond for cultivating microalgae are compared for pure CO2 gas and flue gas injection scenarios. Cooling of the flue gas is modeled for direct-contact heat transfer arrangement. The economic advantage of employing waste heat recovery using indirect-contact heating of the open pond water is investigated as well. An optimization problem is formulated to determine the optimal monthly operations of the open pond and heat exchangers under each scenario. The flue gas injection scenario is found to be more profitable with an improved annual harvest compared to the pure CO2 gas injection case. Waste heat recovery is shown to slightly increase the annual harvest, but is also uneconomical due to the high capital cost of the heat exchanger.

Photosynthetic biogas upgrading using microalgae: Effect of light/dark photoperiod

Fecha de Publicación: Junio 2017
Fuente: Renewable Energy, Volume 106
Autores: L. Meier, P. Barros, A. Torres, C. Vilchez, D. Jeison
Abtract

The use of biogas for grid injection or vehicle fuel requires purification steps to obtain biomethane, process normally called biogas upgrading. The use of microalgae cultures has been proposed as a new alternative for CO2 removal from biogas. Full-scale systems for biogas upgrading using microalgae should be able to deal with natural existing day/night photoperiods. This research evaluated the effect of a light/dark photoperiod on the operation of a photosynthetic biogas upgrading system, at lab-scale conditions. A system based on an open-photobioreactor connected to a mass transfer column was used for that purpose. Using a continuous biogas flow, an upgraded biogas with a CO2 concentration between 2 and 4.5% was obtained throughout light and dark periods. O2 concentrations below 1% in final biogas were observed. Mass balances showed that CO2 desorption was the main process behind CO2 removal. CO2 removal during the dark phase was possible, under the tested conditions, as a result of inorganic carbon desorption from the photobioreactor and accumulation in the liquid phase.

A resettable in-line particle concentrator using AC electrokinetics for distributed monitoring of microalgae in source waters

Fecha de Publicación: Junio 2017
Fuente: Sensors and Actuators B: Chemical, Volume 244

Autores: Quan Yuan, Jayne Wu, Elias Greenbaum, Barbara R. Evans
Abtract

Green algae have been studied as an important and effective biomarker to indicate water quality due to their sensitivity to toxic agents in freshwater sources. However, conventional methods to monitor algal physiology use a chlorophyll fluorometer whose use is hampered by high-cost, large footprint, and limited sensitivity for practical samples containing low algal concentration. To overcome these constraints, we developed a multi-level electrode platform for resettable trapping of algae via AC electro-osmosis (ACEO) and negative dielectrophoresis. Preliminary experiments were performed in freshwater with conductivity of 0.02S/m. Algal trapping was demonstrated at a low voltage of 2V. The concentration effect was experimentally verified by measuring the fluorescence intensity of algae and using hemocytometer counting chambers at the inlet and outlet of the multilevel microchannel lab-on-a-chip. An optimal frequency was found for trapping, which agrees with the frequency dependence of ACEO flow velocity. Through-flow rate and electrode dimensions were optimized as well. Trapping efficiencies within the range of 26%–65% have been obtained. A maximum trapping rate of 182 cells/s was obtained with a flow rate of 20μl/min. This lab-on-a-chip shows high potential for improving the limit of detection in algal monitoring and enabling the development of a portable, integrated and automated system for monitoring the quality of source drinking waters.

Evaluation of anaerobic digestates from different feedstocks as growth media for Tetradesmus obliquus, Botryococcus braunii, Phaeodactylum tricornutum and Arthrospira maxima

Fecha de Publicación: 25 Mayo 2017
Fuente: New Biotechnology, Volume 36
Autores: Marina Massa, Silvia Buono, Antonio Luca Langellotti, Luigi Castaldo, Anna Martello, Antonello Paduano, Raffaele Sacchi, Vincenzo Fogliano
Abtract

In this paper, two freshwater microalgae (Tetradesmus obliquus and Botryococcus braunii), a marine diatom (Phaeodactylum tricornutum) and a photosynthetic cyanobacterium (Arthrospira maxima) were investigated for their ability to grow on liquid digestates (LDs). Three LDs were obtained from anaerobic digestion of different organic wastes: zootechnical (ZW LD), vegetable biomass (VW LD) and the organic fraction of municipal solid wastes (MW LD). All the strains showed the same growth performance on VW LD as on the respective standard media (SM), while ZW LD was efficient only for growth of T. obliquus and B. braunii. MW LD was the poorest growth medium for all the strains. Data on nutrient removal efficiency showed that A. maxima and T.

obliquus made the best use of NH_4^+-N with removal values ranging between 98.9–99.8%, while P. tricornutum and B. braunii showed values of 79.0 and 88.5% respectively. Applying repeated batch cultivation in photobioreactors, the biochemical composition of A. maxima and T. obliquus biomass grown on ZW LD and VW LD, showed an increase of lipid, carbohydrates and ash in both microalgae. Biomass biochemical profiles suggest possible applications in feed, chemicals and energy sectors.

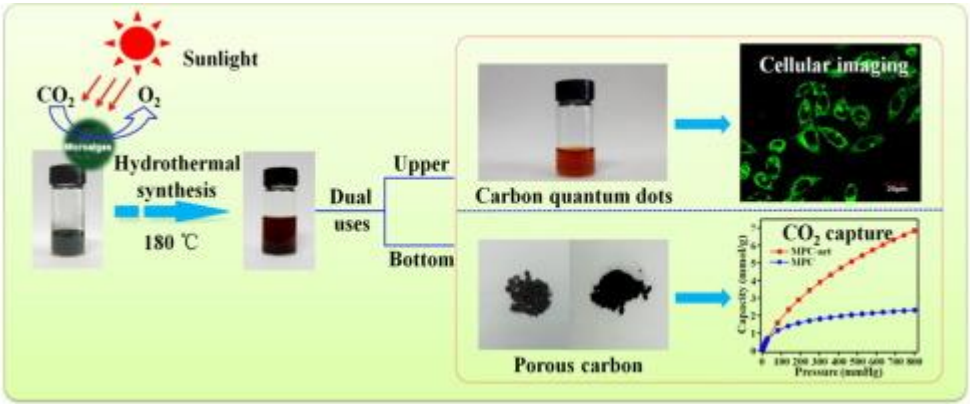
Sustainable microalgae for the simultaneous synthesis of carbon quantum dots for cellular imaging and porous carbon for CO2 capture

Fecha de Publicación: 1 Mayo 2017
Fuente: Journal of Colloid and Interface Science, Volume 493
Autores: Li-Ping Guo, Yan Zhang, Wen-Cui Li

Abtract

Microalgae biomass is a sustainable source with the potential to produce a range of products. However, there is currently a lack of practical and functional processes to enable the high-efficiency utilization of the microalgae. We report here a hydrothermal process to maximize the utilizability of microalgae biomass. Specifically, our concept involves the simultaneous conversion of microalgae to (i) hydrophilic and stable carbon quantum dots and (ii) porous carbon. The synthesis is easily scalable and eco-friendly. The microalgae-derived carbon quantum dots possess a strong two-photon fluorescence property, have a low cytotoxicity and an efficient cellular uptake, and show potential for high contrast bioimaging. The microalgae-based porous carbons show excellent CO2 capture capacities of 6.9 and 4.2mmolg^{-1} at 0 and 25°C respectively, primarily due to the high micropore volume (0.59cm^3 g^{-1}) and large specific surface area (1396m^2 g^{-1}).

Graphical abstract



Mesophilic and thermophilic anaerobic digestion of lipid-extracted microalgae N. gaditana for methane production

Fecha de Publicación: Mayo 2017
Fuente: Renewable Energy, Volume 105
Autores: Gabriel Capson-Tojo, Alvaro Torres, Raúl Muñoz, Jan Bartacek, David Jeison

Abtract

In the last years, a huge effort has been made to make biodiesel production from microalgae a feasible option. Besides the potential of biodiesel for replacing fossil fuels as a cleaner alternative, some limitations have still to be overcome. Among them, the low energy yields of the process and the high-energy requirements of the harvesting and drying steps lead to a high cost per litre of fuel. In this context, anaerobic digestion of the microalgal biomass after lipid extraction can improve the energy balance of the process, by producing methane and revalorizing a waste generated during biodiesel production. In this study, the production of biogas by anaerobic digestion of the marine microalgae Nannochloropsis gaditana after oil extraction was studied. As the hydrolysis is known to be the rate-limiting step of anaerobic digestion of solid substrates, the influence of the process temperature on this step was assessed. For this purpose, two different anaerobic sludges, i.e. mesophilic (35 °C) and thermophilic (55 °C), were used as inocula for different batch tests and for two continuous anaerobic bioreactors. The influence of the oil extraction process on the structural integrity of the microalgae was also studied. The results obtained from scanning electron microscopy and flow cytometry showed that the lipid extraction did not cause cell lysis, but the structure of their surface was affected by the process. Batch assays showed that thermophilic conditions did not improve the biomethane potentials when compared to mesophilic conditions. Two continuous anaerobic bioreactors operated for 120 days confirmed the batch results. However, measurements of the chemical oxygen demand showed that the soluble fraction in the thermophilic reactor was higher than under mesophilic conditions, indicating an improved hydrolysis step. This was confirmed by the results of scanning electron microscopy and flow cytometry, which suggested a more intense disintegration of microalgae in the thermophilic reactor, indicating a greater degree of hydrolysis. Nevertheless, this advantage of thermophilic temperatures over mesophilic conditions did not improve the methane productivity.

Assessment of fuel properties, engine performance and emission characteristics of outdoor grown marine Chlorella vulgaris BDUG 91771 biodiesel

Fecha de Publicación: Mayo 2017
Fuente: Renewable Energy, Volume 105
Autores: Thangavel Mathimani, Tamilkolundu Senthil Kumar, Murugesan Chandrasekar, Lakshmanan Uma, Dharmar Prabaharan

Abtract

The present study investigates the suitability of marine microalga Chlorella vulgaris BDUG 91771 biodiesel to curb the fuel crisis, based on engine performance and emission profile. Initially, biodiesel was produced from outdoor grown Chlorella vulgaris BDUG 91771 and its fuel properties accorded with ASTM D6571 and EN 14214 standards. To evaluate performance and emission characteristics, various Chlorella vulgaris BDUG 91771 biodiesel-diesel blends were prepared and tested in single-cylinder Kirloskar engine under four different load operations (0%, 50%, 75%, 100%). Compression ignition engine fuelled with B40 or B50 biodiesel-diesel blend showed specific fuel consumption (SFC), and brake thermal efficiency (BTE) of 0.306 kg/kWh and 26% respectively at 100% load, which is on par with diesel fuel. Further, engine operated with B50 biodiesel blend evidently reduced the carbon monoxide (CO) and hydrocarbon (HC) emissions by 0.1% and 102 ppm respectively compared to baseline diesel. Notably, diesel emitted 7.5% carbon dioxide (CO2) and 380 ppm nitrogen oxides (NOx) at 100% load, while the optimal blends B40 or B50 reduced CO2 and NOx emissions by 6.1% and 376 ppm respectively. Based on results, present work suggests either B40 or B50 Chlorella vulgaris BDUG 91771 biodiesel – diesel blend could serve as eco-friendly, alternative fuel.

Biosolids and microalgae as alternative binders for biomass fuel briquetting

Fecha de Publicación: 15 Abril 2017
Fuente: Fuel, Volume 194
Autores: Rukayya Ibrahim Muazu, Julia A. Stegemann
Abtract

Binders can be employed to improve the particle adhesion, compressive strength, abrasion resistance and energy content of densified biomass, such as briquettes. They may also reduce the energy cost of producing such briquettes, by reducing the compaction pressure, conditioning temperature and the wear on production equipment. This study explored and compared the effects of three different binders, including starch, enhanced treated biosolids and microalgae, on density, durability, energy content and combustion characteristics of fuel briquettes produced from blends of rice husks, corn cobs and bagasse, in a multilevel factorial design experiment. Briquettes had relaxed unit densities of 1.9–3.3 times the loose biomass bulk density, and were stronger than briquettes from the individual materials, with an average unconfined compressive strength of 125kPa. An unconfined compressive strength of 175kPa was achieved for a 2:4:1 blend of rice husks, corn cobs and bagasse with the microalgae binder at a compaction pressure of 31MPa. Statistical analysis of the results showed that the addition of biosolids and microalgae binders significantly improved briquette density, while the addition of starch reduced briquette density, and biosolids reduced briquette strength. Of all the briquettes produced with the three binders, those containing the microalgae binder were found to be most durable, with a higher energy value, slower mass loss during briquette combustion, and a

higher afterglow time. Since microalgae may be grown using CO2 from biomass combustion, discovery of their advantages as a binder in briquetting is particularly welcome.

Fate of H2S during the cultivation of Chlorella sp. deployed for biogas upgrading

Fecha de Publicación: 15 Abril 2017
Fuente: Journal of Environmental Management, Volume 191
Autores: Armando González-Sánchez, Clemens Posten
Abtract

The H2S may play a key role in the sulfur cycle among the biogas production by the anaerobic digestion of wastes and the biogas upgrading by a microalgae based technology. The biogas is upgraded by contacting with slightly alkaline aqueous microalgae culture, then CO2 and H2S are absorbed. The dissolved H2S could limit or inhibit the microalgae growth. This paper evaluated the role of dissolved H2S and other sulfured byproducts under prevailing biogas upgrading conditions using a microalgal technology. At initial stages of batch cultivation the growth of Chlorella sp. was presumably inhibited by dissolved H2S. After 2 days, the sulfides were oxidized mainly by oxic chemical reactions to sulfate, which was later rapidly assimilated by Chlorella sp., allowing high growing rates. The fate of H2S during the microalgae cultivation at pH > 8.5 was assessed by a mathematical model where the pentasulfide, thiosulfate and sulfite were firstly produced and converted finally to sulfate for posterior assimilation.

Parameterization of a light distribution model for green cell growth of microalgae: Haematococcus pluvialis cultured under red LED lights

Fecha de Publicación: Abril 2017
Fuente: Algal Research, Volume 23
Autores: Xin Gao, Xinyu Wang, Haijun Li, Sanja Roje, Shyam S. Sablani, Shulin Chen
Abtract

A light distribution model is a prerequisite for establishing an algal growth model. Based on approaches to account for light intensity, algal productivity models can be divided into three types, Type I models predict the rate of photosynthesis, Type II models computes productivity and Type III models considers the impacts of both light gradients and short light cycles. Among these,

Type II models may offer the best compromise between accuracy and practicability for full-scale engineering applications. Addressing the need for examining indoor seed preparation of Haematococcus pluvialis under red LED irradiation, this study advanced a Type II model based on light distribution. The model was parameterized for green cell growth of Haematococcus pluvialis using the Gauss-Newton and bootstrap methods. The parameters k1 and k2 from the hyperbolic Beer-Lambert law of the two-flux model were $118.8\pm5.2 m^{-1}$ and $0.25\pm0.04 gL^{-1}$, with 95% confidence intervals of (111.6, 129.8) and (0.20, 0.33), respectively. The parameterized model was validated against experimental results, with the largest error and relative error of $0.08 \mu mol/m^2/s$ and 10.5%, respectively. Validation results demonstrate that the established model was reliable and could accurately predict the light intensity for indoor cultivation of Haematococcus pluvialis in the green stage. This study demonstrated that the effectiveness of using the bootstrap method to accurately estimate the parameters in these types of models. It provided information on model parameters, including standard deviation and 95% confidence intervals. This model also applied many more data points (89 in this study) to estimate parameters to reduce error. The results filled a technological gap for modeling the light distribution of indoor seed preparation of Haematococcus pluvialis under red LED lights. The approach can be used to estimate the values of parameters from parametric models for other similar applications using the bootstrap method.

A study on growth and pyrolysis characteristics of microalgae using Thermogravimetric Analysis-Infrared Spectroscopy and synchrotron Fourier Transform Infrared Spectroscopy

Fecha de Publicación: Abril 2017
Fuente: Bioresource Technology, Volume 229
Autores: Fanghua Li, Srikanth Chakravartula Srivatsa, Warren Batchelor, Sankar Bhattacharya
Abtract

This two-part study firstly investigated Tetraselmis suecica grown in different CO2 (0.04–15%v/v) concentration through indoor and outdoor cultivation systems. A high CO2 concentration led to a high lipid content, and low nitrogen and oxygen content, which are desirable for transport fuel production. Pyrolysis characteristics were investigated by TG-IR and synchrotron IR microscopy. The results show Tetraselmis suecica grown in 10%CO2 had the highest decomposition rate corresponding to more volatile products produced during the main thermal cracking stage and derived from protein-and lipid-corresponding functional groups. Moreover, a high reaction temperature and CO2 concentration resulted in a low retention of surface functional groups. The nitrogen functional groups initially decomposed at a temperature range of 250–

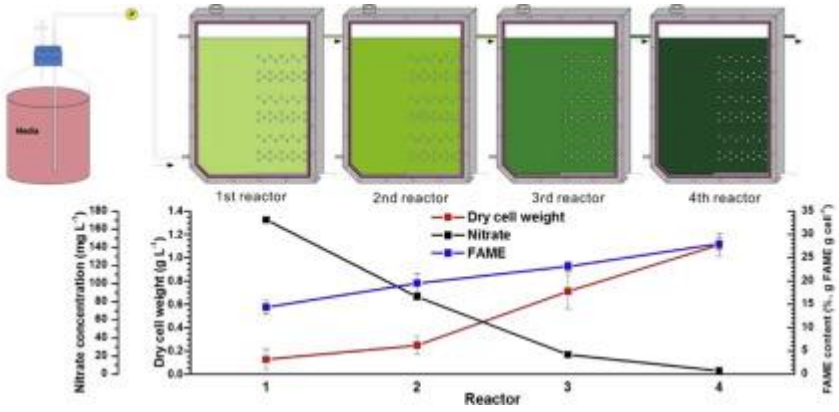
300°C and still remained at 550°C, while the lipid-corresponding functional groups completely disappeared at a temperature range of 400–500°C. Besides, the decomposition of chemical components followed the order of carbohydrate, protein and lipid.

Enhancement of lipid productivity by adopting multi-stage continuous cultivation strategy in Nannochloropsis gaditana

Fecha de Publicación: Abril 2017
Fuente: Bioresource Technology, Volume 229
Autores: Min-Gyu Sung, Bongsoo Lee, Chul Woong Kim, Kibok Nam, Yong Keun Chang
Abtract

In the present study, a novel process-based cultivation system was designed to improve lipid productivity of Nannochloropsis gaditana, an oleaginous microalga that has high potential for biofuel production. Specifically, four flat-panel photobioreactors were connected in series, and this system was subjected to continuous chemostat cultivation by feeding fresh medium to the first reactor at dilution rates of 0.028 and 0.056day^{-1}, which were determined based on Monod kinetics. The results show that the serially connected photobioreactor system achieved 20.0% higher biomass productivity and 46.1% higher fatty acid methyl ester (FAME) productivity than a conventional single photobioreactor with equivalent dilution rate. These results suggest that a process-based approach using serially connected photobioreactors for microalgal cultivation can improve the productivity of lipids that can be used for biofuel production.

Graphical abstract



Pyrolysis characteristics and pathways of protein, lipid and carbohydrate isolated from microalgae Nannochloropsis sp.

Fecha de Publicación: Abril 2017
Fuente: Bioresource Technology, Volume 229
Autores: Xin Wang, Lili Sheng, Xiaoyi Yang
Abtract

Microalgal components were isolated gradually to get lipid-rich, protein-rich and carbohydrate-rich components. The aim of this work was to study pyrolysis mechanism of microalgae by real isolated real algae components. Thermogrametric analysis (DTG) curve of microalgae was fitted by single pyrolysis curves of protein, lipid and carbohydrate except special zones, which likely affected by cell disruption and hydrolysis mass loss. Experimental microalgae liquefaction without water index N was 0.6776, 0.3861 and 0.2856 for isolated lipid, protein and carbohydrate. Pyrolysis pathways of lipid are decarboxylation, decarbonylation, fragmentation of glycerin moieties and steroid to form hydrocarbons, carboxylic acids and esters. Pyrolysis pathways of protein are decarboxylation, deamination, hydrocarbon residue fragmentation, dimerization and fragmentation of peptide bonds to form amide/amines/nitriles, esters, hydrocarbons and N-heterocyclic compounds, especially diketopiperazines (DKPs). Pyrolysis pathways of carbohydrate are dehydrated reactions and further fragmentation to form ketones and aldehyde, decomposition of lignin to form phenols, and fragmentation of lipopolysaccharides.

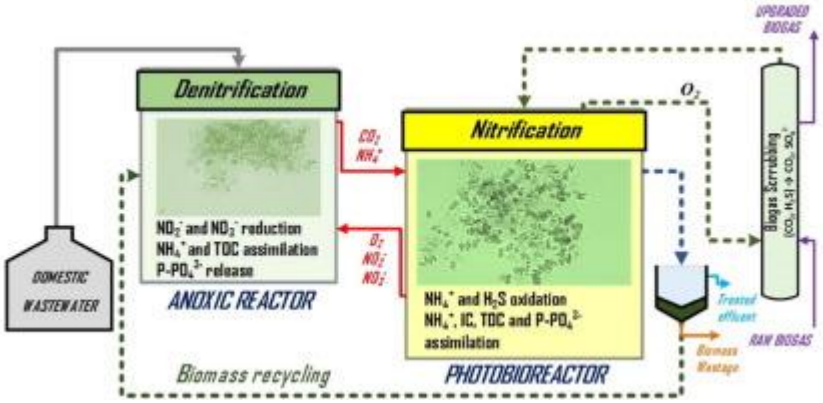
Enhanced carbon, nitrogen and phosphorus removal from domestic wastewater in a novel anoxic-aerobic photobioreactor coupled with biogas upgrading

Fecha de Publicación: 1 Abril 2017
Fuente: Chemical Engineering Journal, Volume 313
Autores: Dimas García, Cynthia Alcántara, Saúl Blanco, Rebeca Pérez, Silvia Bolado, Raúl Muñoz

Abtract

This work evaluated the performance of an innovative anoxic-aerobic algal-bacterial photobioreactor coupled with biogas upgrading for the treatment of domestic wastewater via nitrification-denitrification. The process, which incorporated a biomass settling step followed by recycling to the anoxic tank, was operated at a hydraulic retention time of 2days, a sludge retention time of ≈11days under a 12h/12h light/dark irradiation cycle at 392μEm^{-2} *s^{-1}. An increase in the removal efficiency of TN from 38% to 81%, NH_4^+ from 39% to 97%, and $P\text{-}PO_4^{3-}$ from 59% to 64% were recorded when additional CO_2 was supplied to the photobioreactor via biogas scrubbing, which supported an almost complete nitrification of the NH_4^+ to NO_3^- and promoted microalgae growth (with the subsequent enhancement in N and P assimilation). TOC removal remained constant at 90±2% regardless of the addition of CO_2, while the effluent biomass concentration averaged 26±12mgTSS/L. A DGGE-sequencing analysis of the bacterial community revealed the occurrence of 10phyla, Proteobacteria being the dominant phylum. Finally, the morphological characterization of the microalgae population dynamics revealed a gradual dominance of the genus Scenedesmus, which accounted for 94–100% at the end of the experiment.

Graphical abstract



Third generation algae biofuels in Italy by 2030: A scenario analysis using Bayesian networks

Fecha de Publicación: Abril 2017
Fuente: Energy Policy, Volume 103
Autores: Danilo Gambelli, Francesca Alberti, Francesco Solfanelli, Daniela Vairo, Raffaele Zanoli
Abtract

We have analysed the potential for biofuels from microalgae in the Italian biofuels context. This scenario analysis considers alternative pathways for the adoption of biofuels from microalgae by the year 2030. The scenarios were developed using a probabilistic approach based on Bayesian networks, through a structured process for elicitation of expert knowledge. We have identified the most and least favourable scenarios in terms of the expected likelihood for the development of the market of biofuels from microalgae, through which we have focussed on the contribution of economic and policy aspects in the development of the sector. A detailed analysis of the contribution of each variable in the context of the scenarios is also provided. These data represent a starting point for the evaluation of different policy options for the future biofuel market in Italy. The best scenario shows a 75% probability that biofuels from microalgae will exceed 20% of the biofuel market by 2030. This is conditional on the improvement and development of the technological changes and environmental policies, and of the markets for bioenergy and novel foods derived from microalgae.

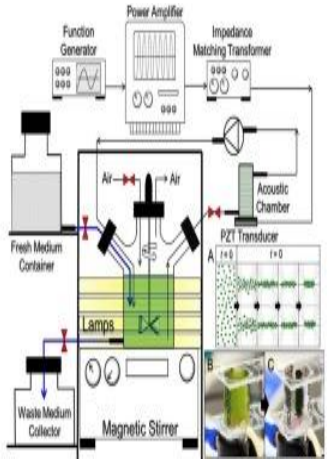
Using Resonant Ultrasound Field-Incorporated Dynamic Photobioreactor System to Enhance Medium Replacement Process for Concentrated Microalgae Cultivation in Continuous Mode

Fecha de Publicación: Disponible online 23 Diciembre 2016
Fuente: Chemical Engineering Research and Design
Autores: Yu-Hsiang Lee, Po-Han Li

Abtract

Holding cells in the cultivation broth for subsequent medium replacement is often considered as one of the most difficult procedures during perfusion cell culture. Although a number of harvest approaches have been reported in the past decades, their drawbacks such as high cost, increased contamination, and/or labor consuming remain obstacles for practical application. To overcome these challenges, a novel resonant ultrasound field-incorporated dynamic photobioreactor system (RUF-DPBS) was developed in which the cell retention and medium replacement are carried out by acoustic radiation forces and gravity, respectively. Based on the collection efficiency of microalgae, the RUF operation was optimized by 1MHz and output intensity of 8W/cm^2 with circulating velocity of 2mL/min whereby 93% of Nannochloropsis oculata in 30mL can be collected within 2-h operation. Moreover, the cells cultured with RUF-DPBS in which the medium was changed every three days exhibited increased volumetric productivity that the yields of biomass, total lipid, and eicosapentaenoic acid of the Nannochloropsis oculata after 12-days cultivation significantly enhanced 2.6, 2.1, and 2.5 folds (P <0.05 for each), respectively, as compared to the group without medium replacement. In summary, the semiautomatic RUF-DPBS offers a non-fouling, labor-efficient, and cost-effective means for high-density microalgae culture in continuous mode.

Graphical abstract



Enhanced microalgal biomass and lipid production from a consortium of indigenous microalgae and bacteria present in municipal wastewater under gradually mixotrophic culture conditions

Fecha de Publicación: Disponible online 25 Diciembre 2016
Fuente: Bioresource Technology

Autores: Hyun Uk Cho, Young Mo Kim, Jong Moon Park

Abtract

The goal of this study was to investigate the influences of gradually mixotrophic culture conditions on microalgal biomass and lipid production by a consortium of indigenous microalgae and bacteria present in raw municipal wastewater. Lab-scale photobioreactors containing the consortium were operated in repeated batch mode. Initial cultivation (phase I) was performed using only the municipal wastewater, then 10% and 25% of the reactor volumes were replaced with the effluent from a sewage sludge fermentation system producing volatile fatty acids (SSFV) at the beginnings of phase II and phase III, respectively. The highest biomass productivity (117.1 ± 2.7 mg/L/d) was attained during phase II, but the lipid productivity (17.2 ± 0.2 mg/L/d) was attained during phase III. The increase in the effluent from the SSFV influenced microalgal diversity with a preference for Chlorella sp., but bacterial diversity increased significantly during phase III.

Graphical abstract

The challenge of measuring biofuel sustainability: A stakeholder-driven approach applied to the French case

Fecha de Publicación: Marzo 2017

Fuente: Renewable and Sustainable Energy Reviews, Volume 69

Autores: Gino Baudry, Florian Delrue, Jack Legrand, Jérémy Pruvost, Thomas Vallée

Abtract

Measuring biofuel sustainability requires dealing with a wide variety of complex and conflicting values at stake. Consequently, the biofuel capacity to contribute to one specific value cannot lead to any absolute conclusion about the overall sustainability of biofuel. The scope of the sustainability concept may vary depending on individuals' preferences, the time scale and the geographical region. Based on the 5 pillars sustainability concept that includes social, economic, environmental, legal and cultural considerations, the present study proposes to assess several biofuel sustainability options for France by 2030 through a stakeholder-driven approach. Rather than seeking to reach a consensus, our approach allows us to capture the wide diversity of stakeholders' perspectives and preferences. French stakeholders perceive 22 different

sustainability criteria for biofuels with a very low level of agreement between the different segments of professions (feedstock producers, biofuel producers, refining industry, fuel distributors, car manufacturers, end-users, government and NGOs). In order to operationalize the sustainability assessment, a set of indicators has been identified with stakeholders that allows us to measure the capacity of biofuels to fulfill each of their criteria. Seventeen biofuel options were assessed with regards to economic, social, environmental, cultural and legal considerations, allowing the identification of the strengths and weaknesses of each biofuel.

A photobioreactor for microalgae cultivation with internal illumination considering flashing light effect and optimized light-source arrangement

Fecha de Publicación: 1 Febrero 2017
Fuente: Energy Conversion and Management, Volume 133
Autores: Jin-Yang Hu, Toru Sato
Abtract

In this study, a photobioreactor for mass-culturing microalgae was developed. Because of the optimized arrangement of internal light-emitting diode (LED) illumination, a major advantage to this reactor is that the volume of the reactor vessel is not limited. Using Dunaliella tertiolecta as the microalgae, the bioreactor displayed the flashing-light effect of the microalgae photosynthesis process. This phenomenon was achieved using a series of blue and red LEDs set at appropriate positions within the reactor to evenly distribute the light intensity. Our experimental results suggested that the maximum cell density in the culture experiment was 1.88×10^{3} cellsL^{-1}, which is approximately 67% of the maximum density under ideal conditions. The harvest yield of the algae was estimated by a numerical model using measured parameters; it was predicted that the bioreactor developed in this study can attain a high growth rate of D. tertiolecta by controlling the distance between LEDs.

PATENTES

PROCESS FOR ENRICHMENT OF MICROALGAL BIOMASS WITH CAROTENOIDS AND WITH PROTEINS

Page bookmark	CN105793433 (A) - PROCESS FOR ENRICHMENT OF MICROALGAL BIOMASS WITH CAROTENOIDS AND WITH PROTEINS

Inventor(s): COSSART MATHIEU; DEFRETIN SOPHIE; MACQUART GABRIEL; SEGUEILHA LAURENT + (COSSART MATHIEU, ; DEFRETIN SOPHIE, ; MACQUART GABRIEL, ; SEGUEILHA LAURENT)

Applicant(s): ROQUETTE FRERES + (ROQUETTE FRERES)

Abstract of CN105793433 (A)

The invention relates to a process for the enrichment, with carotenoids and proteins, of a biomass of a microalga cultivated under heterotrophic conditions, wherein said microalga is of the Chlorella genus, which comprises culturing said microalga in a minimum medium supplemented with a nitrogen source in organic form, preferably chosen from the group consisting of yeast extract, corn steep liquor, and a combination thereof.

PREPARATION METHOD OF BIODIESEL FROM WET MICROALGAE

Page bookmark: KR20160077395 (A) - PREPARATION METHOD OF BIODIESEL FROM WET MICROALGAE

Inventor(s): HWANGBO JUN KWON [KR] + (HWANGBO, JUN KWON)

Applicant(s): RES INST IND SCIENCE & TECH [KR] + (RESEARCH INSTITUTE OF INDUSTRIAL SCIENCE & TECHNOLOGY)

Abstract of KR20160077395 (A)

The present invention provides a method of producing biodiesel from wet microalgae. The method comprises: a pretreating process of inputting an acid to wet microalgae; an extracting and converting process of inputting alcohol and hexane to the pretreated wet microalgae to extract lipids and converting the extracted lipids to biodiesel; and a refining process of inputting the acid to the biodiesel to refine the same. The method has effects of: reducing facility construction costs as the method uses a phase separation method in which all processes are performed in one reactor; reducing process operating costs as the method uses wet microalgae which does not need a dry process; and enhancing the purity of the biodiesel as the method comprises the refining process.

Microalgae large-scale harvesting method

Page bookmark: CN105670935 (A) - Microalgae large-scale harvesting method

Inventor(s): ZHANG LI; ZHAO KUI; LI RUNZHI + (ZHANG LI, ; ZHAO KUI, ; LI RUNZHI)

Applicant(s): ZHANG LI; ZHAO KUI; LI RUNZHI + (ZHANG LI, ; ZHAO KUI, ; LI RUNZHI)

Abstract of CN105670935 (A)

The invention discloses a microalgae large-scale harvesting method.The method comprises the following steps that concentration and volume of biomass in a microalgae stock solution are measured before microalgae harvesting; polyglutamic acid is added to the microalgae stock solution, sufficient stirring is conducted until uniformity is achieved, cultivation continues to be conducted for 1-5 days, then, PH is adjusted to 6-10, microbial flocculant obtained by culturing bacillus RP1137 is added, processing is conducted for 30-40 s at the normal temperature, the mixture is put into a glass separator, and standing and flocculating are conducted to enable the mixture to be layered; microalgae biomass on the lower layer is collected, dehydrated and dried.Flocculation processing is conducted on the microalgae stock solution through polyglutamic acid and microbial flocculant, large-scale harvesting of microalgae is achieved, the collection rate can reach 90-95%, the temperature does not need to be adjusted in the whole flocculation process, and cost is further reduced while use is convenient; polyglutamic acid is free of poison and harmless, can not damage water, and can be absorbed and utilized by algae cells to promote microalgae to continue to grow, and cyclic utilization of culture liquid is achieved.

Method for accumulating carbohydrates by coupling microalgae with biogas slurry

Page bookmark	CN105603019 (A) - Method for accumulating carbohydrates by coupling microalgae with biogas slurry
Inventor(s):	LI QINGBIAO; TAN FEN; WANG YUANPENG; HE NING; WANG HAITAO + (LI QINGBIAO, ; TAN FEN, ; WANG YUANPENG, ; HE NING, ; WANG HAITAO)
Applicant(s):	UNIV XIAMEN + (XIAMEN UNIVERSITY)

Abstract of CN105603019 (A)

The invention relates to a method for accumulating carbohydrates by coupling microalgae with biogas slurry, relating to carbohydrates. The method comprises the following steps: preserving microalgae on a solid culture medium by a plate streak process; taking the microalgae from the microalgae plate, inoculating the microalgae into a Modified 3N medium culture solution, and culturing to obtain a microalgae seed culture solution; by utilizing the direct proportion relation between biomass and OD685, establishing a standard curve between the biomass and OD685; taking biogas slurry from an anaerobic fermentation tank, centrifugating and taking the supernatant; diluting the supernatant, transferring the diluted supernatant into an batch-type photoreactor, inoculating and culturing, regularly determining the changes of the microalgae biomass and nutrient, and evaluating the experiment effect; and collecting the microalgae, carrying out freeze-drying, crushing, treating in a water bath, hydrolyzing, and determining the carbohydrate content in the microalgae. The biogas slurry coupled microalgae culture lowers the microalgae culture cost, and purifies the biogas slurry wastewater. The carbohydrate fermentation can generate

bioethanol, thereby implementing reutilization and energy source regeneration on the biogas slurry.

Method for increasing yield of microalgae grease with saccharose as carbon source through co-cultur

Page bookmark CN105441524 (A) - Method for increasing yield of microalgae grease with saccharose as carbon source through co-culture

Inventor(s): WANG SHIKAI; WANG JUAN + (WANG SHIKAI, ; WANG JUAN)

Applicant(s): UNIV YANGZHOU + (YANGZHOU UNIVERSITY)

Abstract of CN105441524 (A)

The invention provides a method for increasing the yield of microalgae grease with saccharose as a carbon source through co-culture. The method comprises the following steps that firstly, saccharose or a saccharose substitute is added in a conventional microalgae culture medium, and the mixture is sterilized for use; secondly, cells of microalgae capable of generating grease in the ogarithmic growth period are selected and collected, and the cells of the microalgae and yeast with extracellular sucrase activity are mixed at the proportion of 25:1-2:1, and inoculated into the microalgae culture medium; thirdly, culture is carried out under the ventilation condition, and a mixture of microalgae bodies and yeast thalli is collected and used for extracting the grease. The method has the advantages that the microalgae which contain rich grease but are poor in single saccharose utilization capability and the yeast which has the extracellular sucrase secretion capability and can accumulate grease are co-cultured, the energy source microalgae can normally grow in the culture medium with saccharose as the carbon source and accumulate the grease together with the yeast, the problem that saccharose cannot be used by the microalgae capable of generating the grease is effectively solved, and the production cost of the grease in the heterotrophic culture process is reduced.

BIOPRODUCTOS

PUBLICACIONES

Enhanced coal-dependent methanogenesis coupled with algal biofuels: Potential water recycle and carbon capture

Fecha de Publicación: 15 Febrero 2017
Fuente: International Journal of Coal Geology, Volume 171
Autores: Elliott P. Barnhart, Katherine J. Davis, Matthew Varonka, William Orem, Alfred B. Cunningham, Bradley D. Ramsay, Matthew W. Fields

Abstract

Many coal beds contain microbial communities that can convert coal to natural gas (coalbed methane). Native microorganisms were obtained from Powder River Basin (PRB) coal seams with a diffusive microbial sampler placed downhole and used as an inoculum for enrichments with different nutrients to investigate microbially-enhanced coalbed methane production (MECoM). Coal-dependent methanogenesis more than doubled when yeast extract (YE) and several less complex components (proteins and amino acids) were added to the laboratory microcosms. Stimulated coal-dependent methanogenesis with peptone was 86% of that with YE while glutamate-stimulated activity was 65% of that with YE, and a vitamin mix had only 33% of the YE stimulated activity. For field application of MECoM, there is interest in identifying cost-effective alternatives to YE and other expensive nutrients. In laboratory studies, adding algal extract (AE) with lipids removed stimulated coal-dependent methanogenesis and the activity was 60% of that with YE at 27d and almost 90% of YE activity at 1406d. Analysis of British Thermal Unit (BTU) content of coal (a measure of potential energy yield) from long-term incubations indicated >99.5% of BTU content remained after coalbed methane (CBM) stimulation with either AE or YE. Thus, the coal resource remains largely unchanged following stimulated microbial methane production. Algal CBM stimulation could lead to technologies that utilize coupled biological systems (photosynthesis and methane production) that sustainably enhance CBM production and generate algal biofuels while also sequestering carbon dioxide (CO2).

Nutrient Removal and Energy Production from Aqueous Phase of Bio-Oil Generated via Hydrothermal Liquefaction of Algae

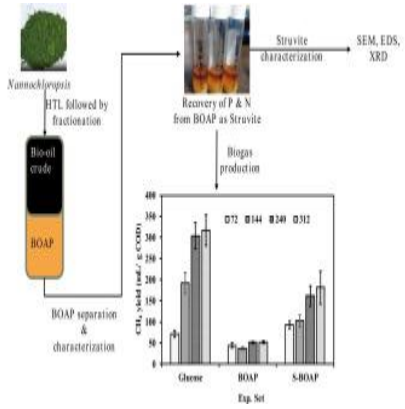
Fecha de Publicación: Disponible online 19 Enero 2017
Fuente: Bioresource Technology

Autores: Saravanan R. Shanmugam, Sushil Adhikari, Rajdeep Shakya

Abstract

Removal of nutrients (phosphorus and nitrogen) as struvite from bio-oil aqueous phase generated via hydrothermal liquefaction of algae was evaluated in this study. Effect of process parameters such as pH, temperature and reaction time on struvite formation was studied. More than 99% of phosphorus and 40-100% nitrogen (NH_4^+-N) were removed under all experimental conditions. X-ray diffraction analysis confirmed the formation of struvite, and the struvite recovered from bio-oil aqueous phase can be used as a slow-release fertilizer. Biogas production from struvite recovered bio-oil aqueous phase showed 3.5 times higher CH_4 yield (182 ± 39 mL/g COD) as compared to non-struvite recovered BOAP fed cultures. The results from this study indicate that both struvite and methane can be produced from bio-oil aqueous phase.

Graphical abstract



Comparative transcriptomic analysis reveals phenol tolerance mechanism of evolved Chlorella strain

Fecha de Publicación: Marzo 2017

Fuente: Bioresource Technology, Volume 227

Autores: Lin Zhou, Dujia Cheng, Liang Wang, Juan Gao, Quanyu Zhao, Wei Wei, Yuhan Sun

Abstract

The growth of microalgae is inhibited by high concentration phenol due to reactive oxygen species. An evolved strain tolerated to 500mg/L phenol, Chlorella sp. L5, was obtained in previous study. In this study, comparative transcriptomic analysis was performed for Chlorella sp. L5 and its original strain (Chlorella sp. L3). The tolerance mechanism of Chlorella sp. L5 for high concentration phenol was explored on genome scale. It was identified that the

up-regulations of the related genes according to antioxidant enzymes (SOD, APX, CAT and GR) and carotenoids (astaxanthin, lutein and lycopene) biosynthesis had critical roles to tolerate high concentration phenol. In addition, most of genes of PS I, PS II, photosynthetic electron transport chain and starch biosynthesis were also up-regulated. It was consistent to the experimental results of total carbohydrate contents of Chlorella sp. L3 and Chlorella sp. L5 under 0mg/L and 500mg/L phenol.

κ-Carrageenan: An effective drug carrier to deliver curcumin in cancer cells and to induce apoptosis

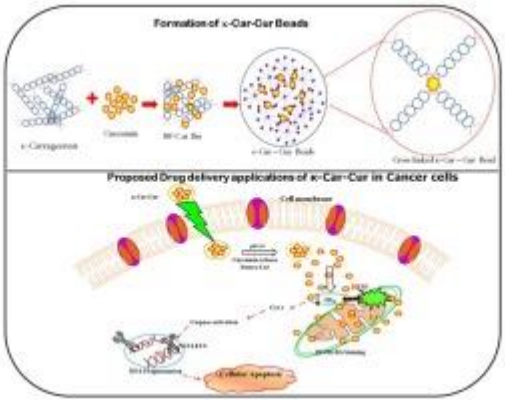
Fecha de Publicación: 15 Marzo 2017
Fuente: Carbohydrate Polymers, Volume 160
Autores: Malairaj Sathuvan, Ramar Thangam, Mani Gajendiran, Raju Vivek, Sengottuvelan Balasubramanian, Subramani Nagaraj, Palani Gunasekaran, Balaraman Madhan, Ramasamy Rengasamy

Abstract

The current study is to develop a natural drug carrier with seaweed derived polymers namely κ-Carrageenan (κ-Car) for drug delivery applications. κ-Car is a natural polysaccharide which derived from edible red seaweeds, they are easily available, non-toxic, cost effective, biodegradable and biocompatible nature. Curcumin (Cur) is a yellow-orange polyphenol existing in turmeric, which is predominantly used as spice and food coloring agent. The ultimate use of polymeric composites, especially those composed of natural polymers, has become a very interesting approach in recent drug delivery applications, due to their non-toxicity and biological origin. In this study the primary approach which depends on the loading of Curcumin into κ-Carrageenan was accomplished, and which (κ-Car-Cur) an active drug carrier was developed for drug delivery against selected lung cancer cells (A549). Thus, the κ-Car-Cur was synthesized by solvent evaporation method followed by freeze drying, and it was further characterized. From this study, it has been reported that the high encapsulation efficiency, good stability, and successful release of Cur from the carrier (κ-Car) was achieved. The drug release was more active at acidic pH 5.0 with the cumulative release of 78%, which is the favorable condition present in tumor microenvironments. The in vitro cellular applications studies of κ-Car-Cur demonstrated that, κ-Car-Cur composites induced higher cytotoxicity against selected cancer cells than free Cur and effectively involved to trigger cellular apoptosis in A549 cancer cells. Further, it was also possessed that inhibition of cell growth and changes in metabolic activity of cancer cells are the unique characteristic features of cellular apoptosis, through reactive oxygen species (ROS) generation. It also observed that there was a decrease in mitochondrial membrane potential (ΔψmΔψm) which leads to a cellular apoptosis during treatment with κ-Car-Cur. Hence, the study outcomes may provide the potential

outline for the use of κ-Car-Cur as a promising tool to deliver drugs at intracellular level.

Graphical abstract



Involvement of Chlamydomonas DNA damage tolerence gene UBC2 in lipid accumulation

Fecha de Publicación: Marzo 2017
Fuente: Algal Research, Volume 22
Autores: Xiaowen Fei, Xinhan Li, Ping Li, Xiaodong Deng
Abstract

The Lys-63–linked polyubiquitination of target proteins is considered a fundamentally different process from conventional Lys-48–linked polyubiquitination. This process is deemed analogous to other post-translational regulatory processes, such as phosphorylation and sumoylation, which alter target protein activities and are reported to be involved in several cellular processes. In this study, we report that CrUBC2, a yeast and Arabidopsis MMS2/UEV homolog gene in Chlamydomonas reinhardtii, is able to functionally rescue yeast mms2 mutant, leading to increased DNA damage tolerance. The overexpression of the CrUBC2 improves the algal ability to tolerate DNA damage, while silencing CrUBC2 sensitizes cells to DNA damage, indicating that CrUBC2 is involved in DNA-damage response in Chlamydomonas. Moreover, the overexpression of CrUBC2 increases algal cell lipid, while the silencing of CrUBC2 gene decreases lipid content, implying that a protein substrate of CrUBC13–CrUBC2 polyubiquitination is involved in lipid accumulation.

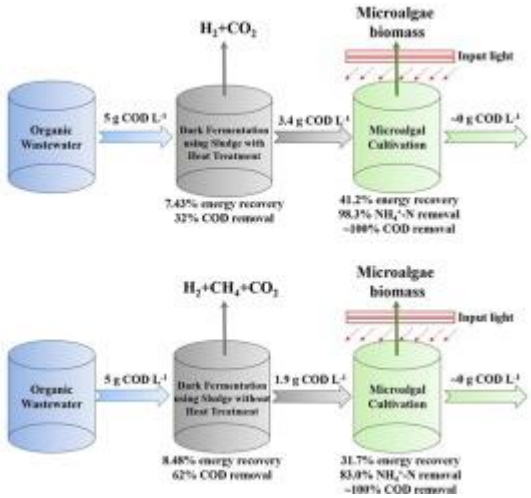
High-strength fermentable wastewater reclamation through a sequential process of anaerobic fermentation followed by microalgae cultivation

Fecha de Publicación: Marzo 2017
Fuente: Bioresource Technology, Volume 227
Autores: Wenqiang Qi, Taojing Chen, Liang Wang, Minghong Wu, Quanyu Zhao, Wei Wei

Abstract

In this study, the sequential process of anaerobic fermentation followed by microalgae cultivation was evaluated from both nutrient and energy recovery standpoints. The effects of different fermentation type on the biogas generation, broth metabolites' composition, algal growth and nutrients' utilization, and energy conversion efficiencies for the whole processes were discussed. When the fermentation was designed to produce hydrogen-dominating biogas, the total energy conversion efficiency (TECE) of the sequential process was higher than that of the methane fermentation one. With the production of hydrogen in anaerobic fermentation, more organic carbon metabolites were left in the broth to support better algal growth with more efficient incorporation of ammonia nitrogen. By applying the sequential process, the heat value conversion efficiency (HVCE) for the wastewater could reach 41.2%, if methane was avoided in the fermentation biogas. The removal efficiencies of organic metabolites and NH_4^+-N in the better case were 100% and 98.3%, respectively.

Graphical abstract



Dynamic model with experimental validation of a biogas-fed SOFC plant

Fecha de Publicación: 1 Marzo 2017
Fuente: Energy Conversion and Management, Volume 135
Autores: G. D'Andrea, M. Gandiglio, A. Lanzini, M. Santarelli
Abstract

The dynamic model of a poly-generation system based on a biogas-fed solid oxide fuel cell (SOFC) plant is presented in this paper. The poly-generation plant was developed in the framework of the FP7 EU-funded project SOFCOM (www.sofcom.eu), which consists of a fuel-cell based polygeneration plant with CO2 capture and re-use. CO2 is recovered from the anode exhaust of the SOFC (after oxy-combustion, cooling and water condensation) and the Carbon is fixed in the form of micro-algae in a tubular photobioreactor. This work focuses on the dynamic operation of the SOFC module running on steam-reformed biogas. Both steady state and dynamic operation of the fuel cell stack and the related Balance-of-Plant (BoP) has been modeled in order to simulate the thermal behavior and performance of the system. The model was validated against experimental data gathered during the operation of the SOFCOM proof-of-concept showing good agreement with the experimental data. The validated model has been used to investigate further on the harsh off-design operation of the proof-of-concept. Simulation results provide guidelines for an improved design of the control system of the plant, highlighting the feasible operating region under safe conditions and means to maximize the overall system efficiency.

Synergistic effects from co-pyrolysis of low-rank coal and model components of microalgae biomass

Fecha de Publicación: 1 Marzo 2017
Fuente: Energy Conversion and Management, Volume 135
Autores: Zhiqiang Wu, Wangcai Yang, Xueyu Tian, Bolun Yang
Abstract

Synergistic effects from co-pyrolysis microalgae biomass with low-rank coal were investigated in this work. Model compounds of three main component in microalgae algae (glycine, medium chain triglyceride and starch), spirulina and simulated spirulina were chosen to Shenfu bituminous pyrolysis process. Kinetic parameters were solved through isoconversional method, and scanning electron microscopy with energy dispersive spectroscopy were applied for characterizing

the char samples. Results revealed synergistic effects occurred with different forms from co-pyrolysis of microalgae primary compounds and coal. Positive synergistic effects, which were defined as higher volatile yield than calculated value, were found in medium chain triglyceride and coal mixtures at all mass ratio. Whether positive or negative synergistic effects on products yield from glycine or starch blended with coal hinged on the temperature and mixing ratio. Both spirulina and simulated spirulina show optimal performance on volatile yields under 50wt.% mass ratio. Non-additivity phenomenon was observed on the distribution of average activation energy. Synergistic effects from co-pyrolysis of coal and microalgae biomass may attributes to the integrative action of the three model compounds.

Enhanced the energy outcomes from microalgal biomass by the novel biopretreatment

Fecha de Publicación: 1 Marzo 2017
Fuente: Energy Conversion and Management, Volume 135
Autores: Shuai He, Xiaolei Fan, Shengjun Luo, Naveen Reddy Katukuri, Rongbo Guo
Abstract

Microalgae have been considered as one of the most promising biomass for the generation of biofuels. The anaerobic digestion (AD) has been proved to be a promising technique to transfer the microalgal biomass into biofuels. Previous study demonstrated that anaerobic pretreatment of microalgae biomass by Bacillus licheniformis could improve methane production. In this study micro-aerobic bio-pretreatment of microalgal biomass by the facultative anaerobic bacteria Bacillus licheniformis was invested with different loads of oxygen supplied. The bio-hydrogen and biomethane productions were tested to calculate total energy outcomes. The transmission electron microscope (TEM) photographs suggested that the novel micro-aerobic bio-pretreatment (MBP) could effectively damage the firm cell wall of algal cells. The processing time of the novel method (24h) was less than the previous anaerobic pretreatment (60h). Results showed that the group with 5mL oxygen/g VSfed had the highest total energy outcomes, which was 17.6% higher than that of the anaerobic pretreatment.

Optimal integration of a self sustained algae based facility with solar and/or wind energy

Fecha de Publicación: 1 Marzo 2017

Fuente: Journal of Cleaner Production, Volume 145
Autores: Mariano Martín, Ignacio E. Grossmann
Abstract

In this work we develop a conceptual design for an integrated facility that produces biodiesel using solar and/or wind energy and carbon dioxide. Microalgae are grown to accumulate lipids that are extracted. The methanol needed for the transesterification is synthesized from carbon dioxide and electrolytic hydrogen. The electricity for the complex is produced using solar panels or wind turbines. The flowsheet is formulated as a multiperiod mixed-integer nonlinear programming problem whose solution provides the optimal source of energy and the operating conditions over a year for an average production of 60 Mgal/yr of biodiesel. The facility requires an investment of 120 M€ for a production cost of 0.79€/gal (0.25 €/kg). The energy consumption is 3.2 MJ/gal of biodiesel capturing 4.05 kg of carbon dioxide per kg of biodiesel and consuming 1L/L of water including the operation of the cooling tower and the boiler.

Green production of microalgae-based silver chloride nanoparticles with antimicrobial activity against pathogenic bacteria

Fecha de Publicación: Febrero 2017
Fuente: Enzyme and Microbial Technology, Volume 97
Autores: Veronica da Silva Ferreira, Mateus Eugenio ConzFerreira, Luís Maurício T.R. Lima, Susana Frasés, Wanderley de Souza, Celso Sant'Anna
Abstract

Silver nanoparticles are powerful antimicrobial agents. Here, the synthesis of silver chloride nanoparticles (AgCl-NPs) was consistently evidenced from a commercially valuable microalgae species, Chlorella vulgaris. Incubation of C. vulgaris conditioned medium with AgNO3 resulted in a medium color change to yellow/brown (with UV–vis absorbance at 415nm), indicative of silver nanoparticle formation. Energy-dispersive X-ray spectroscopy (EDS) of purified nanoparticles confirmed the presence of both silver and chlorine atoms, and X-ray diffraction (XRD) showed the typical pattern of cubic crystalline AgCl-NPs. Transmission electron microscopy (TEM) showed that most particles (65%) were spherical, with average diameter of 9.8±5.7nm. Fourier transform infrared spectroscopy (FTIR) of purified nanoparticle fractions suggested that proteins are the main molecular entities involved in AgCl-NP formation and stabilization. AgCl-NPs (from 10μg/mL) decreased by 98% the growth of Gram-positive Staphylococcus aureus and Gram-negative Klebsiella pneumoniae bacterial pathogens, and had a dose-dependent effect on cell viability, which was measured by automated image-based high content screening (HCS). Ultrastructural analysis of treated bacteria by TEM revealed the abnormal

arrangement of the chromosomal DNA. Our findings strongly indicated that the AgCl-NPs from C. vulgaris conditioned medium is a promising 'green' alternative for biomedical application as antimicrobials.

Economic feasibility of microalgal bacterial floc production for wastewater treatment and biomass valorization: A detailed up-to-date analysis of up-scaled pilot results

Fecha de Publicación: Enero 2017
Fuente: Bioresource Technology, Volume 224
Autores: Elien Vulsteke, Sofie Van Den Hende, Lode Bourez, Henk Capoen, Diederik P.L. Rousseau, Johan Albrecht
Abstract

The economic potential of outdoor microalgal bacterial floc (MaB-floc) raceway ponds as wastewater treatment technology and bioresource of biomass for fertilizer, shrimp feed, phycobiliproteins and biogas in Northwest Europe is assessed. This assessment is based on cost data provided by industry experts, on experimental data obtained from pilot-scale outdoor MaB-floc ponds treating aquaculture and food-industry effluents, and from different biomass valorization tests. MaB-floc ponds exhibit a cost-performance of EUR 0.25–0.50m^{-3} wastewater which is similar to conventional wastewater treatment technologies. The production cost of MaB-flocs in aquaculture and food industry effluent is EUR 5.29 and 8.07kg^{-1} TSS, respectively. Capital costs and pond mixing costs are the major expenses. Commercializing MaB-flocs as aquaculture feed generates substantial revenues, but the largest profit potential lies in production of high-purity phycobiliproteins from MaB-flocs. These results highlight the large economic potential of MaB-floc technology, and justify its further development.

Cytotoxic effect of Spirulina platensis extracts on human acute leukemia Kasumi-1 and chronic myelogenous leukemia K-562 cell lines

Fecha de Publicación: Enero 2017
Fuente: Asian Pacific Journal of Tropical Biomedicine, Volume 7, Issue 1
Autores: Flor Yohana Flores Hernandez, Sanghamitra Khandual, Inocencia Guadalupe Ramírez López
Abstract

Objective To evaluate the cytotoxic effects of Spirulina platensis extracts on acute leukemia Kasumi-1 and chronic leukemia K-562 cancer cell lines. Methods Various concentrations of Spirulina platensis extracts (0.25–50.00 mg/mL)

obtained with different solvents were used to treat cell lines for 72 h. For cytotoxic effect studies, cell viability test with trypan blue solution, MTT assay and microscopic cytomorphological assessment were done. Results Spirulina extract obtained with 70% ethanol showed significant cytotoxicity in K562 and Kasumi-1 cell lines. With trypan blue solution, IC50 values were found to be 4.64 mg/mL for K-562 and 3.68 mg/mL for Kusumi-1 cell lines. Spirulina aqueous extract also showed cytotoxicity with trypan blue method, at a slightly higher dose; where IC50 values were 12.68 mg/mL for K-562 and 2.13 mg/mL for Kusumi-1 cell lines. The IC50 values were found 0.40 mg/mL for K-562 and 0.31 mg/mL for Kusumi-1 cell lines for the 70% ethanol extract according to the MTT assay. Spirulina extract obtained with water also showed cytotoxicity but the dose was a little higher where IC50 values were 15.77 mg/mL for K-562 and 9.44 mg/mL for Kusumi-1 cell lines. The effect of cytotoxicity with ethanol extract is quite comparable with that observed for cyclophosphamide, which is a chemical used as anticancer agent. Conclusions The cytotoxicity exhibited by Spirulina extract to cancer cell lines might be due to the presence of phytopigments (carotenoids, chlorophyll, phycocyanin) as well as polysaccharides that were reported previously as constituents of the extract. So crude extracts of Spirulina can be used as a source to develop anticancer drugs.

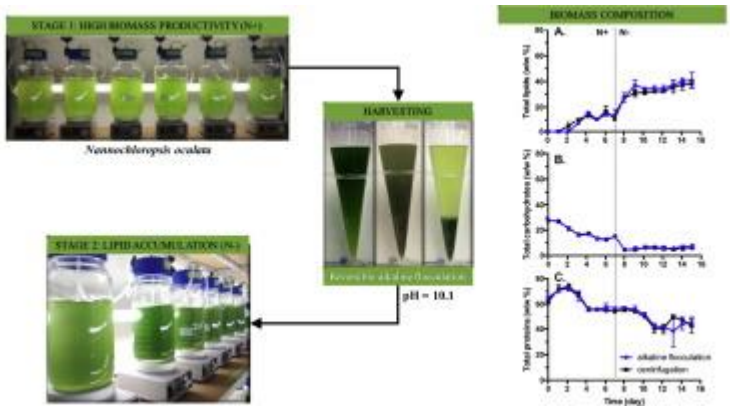
Two-stage cultivation of Nannochloropsis oculata for lipid production using reversible alkaline flocculation

Fecha de Publicación: Febrero 2017
Fuente: Bioresource Technology, Volume 226
Autores: Gibran Sidney Aléman-Nava, Koenraad Muylaert, Sara Paulina Cuellar Bermudez, Orily Depraetere, Bruce Rittmann, Roberto Parra-Saldívar, Dries Vandamme
Abstract

Two-stage cultivation for microalgae biomass is a promising strategy to boost lipid accumulation and productivity. Most of the currently described processes use energy-intensive centrifugation for cell separation after the first cultivation stage. This laboratory study evaluated alkaline flocculation as low-cost alternative separation method to harvest Nannochloropsis oculata prior to cultivation in the second nutrient-depleted cultivation stage. Biomass concentration over time and the maximum quantum yield of photosystem II expressed as Fv:Fm ratio showed identical patterns for both harvesting methods in both stages. The composition of total lipids, carbohydrates, and protein was similar for biomass harvested via alkaline flocculation or centrifugation. Likewise, both harvest methods yielded the same increase in total lipid content, to 40% within the first 2days of the nutrient-depleted stage, with an enrichment in C16 fatty acid methyl esters. Centrifugation can therefore be replaced with

alkaline flocculation to harvest Nannochloropsis oculata after the first cultivation stage.

Graphical abstract



Effects of selenite on green microalga Haematococcus pluvialis: Bioaccumulation of selenium and enhancement of astaxanthin production

Fecha de Publicación: Febrero 2017
Fuente: Aquatic Toxicology, Volume 183
Autores: Yihong Zheng, Ze Li, Ming Tao, Jiancheng Li, Zhangli Hu
Abstract

Algae are at a low trophic level and play a crucial role in aquatic food webs. They can uptake and accumulate the trace element selenium (Se), which can be either essential or toxic to algal growth depending on the dosage and species. Se toxicity and algae resistance varied across different organisms. In order to investigate the effects of Se on the unicellular green alga Haematococcus pluvialis, an important industrial resource for natural astaxanthin, the algal growth rate, chlorophyll content, and fluorescence parameters were derived from experimental treatment with different concentrations of selenite. The results showed that the EC50 for the algal growth rate was 24mg/L, and that a low dosage of selenite (3mg/L) may not hinder H. pluvialis cell growth, but selenite at levels higher than 13mg/L do restrain cell growth. Bioaccumulation experiments showed that H. pluvialis accumulated up to 646μg/g total Se and 380μg/g organic Se, dry weight. However, treatment with high concentrations of selenite significantly increased intracellular hydrogen peroxide levels, antioxidant enzyme activity, and the production of astaxanthin, suggesting that Se bioaccumulation might be toxic to H. pluvialis.

Levelized cost of energy and financial evaluation for biobutanol, algal biodiesel and biohydrogen during commercial development

Fecha de Publicación: 14 Diciembre 2016
Fuente: International Journal of Hydrogen Energy, Volume 41, Issue 46
Autores: Duu-Hwa Lee
Abstract

This study applies engineering economic analysis with modifications that concern profit rate, opportunity cost, price inflation, financial leverage, risk premium, learning curve effect, the effect of nth-generation chemical plants effect, interest rate and full commercializatioguren to capture realistic conditions to evaluate the economic feasibility of biohydrogen, biobutanol and algal biodiesel plants in a future bioeconomy. Analytical results reveal that biohydrogen and biobutanol can replace fossil fuels with high economic feasibility. Biohydrogen has the most flexibility under variation in the production cost of biomass feedstock. Algae biodiesel is less financially competitive than biohydrogen and biobutanol. Three bioenergies are cost-competitive with fossil fuels under ideal conditions. Sensitivity analysis reveals that biomass feedstock cost more strongly affects the financial performance of bioenergy than does operating and Maintenance (O&M) cost. Interest rate has the greatest impact on levelized cost of energy (LCOE), and is followed in that respect by price inflation, economic incentives and the two-tier learning curve effect. The factors that are related of bioenergy should be paid considerable attention to maintain the stability of biomass feedstock supply to make bioenergy competitive with fossil fuels.

Antioxidant capacities of fucoxanthin-producing algae as influenced by their carotenoid and phenolic contents

Fecha de Publicación: 10 Enero 2017
Fuente: Journal of Biotechnology, Volume 241
Autores: Su Chern Foo, Fatimah Md. Yusoff, Maznah Ismail, Mahiran Basri, Sook Kun Yau, Nicholas M.H. Khong, Kim Wei Chan, Mahdi Ebrahimi
Abstract

Natural antioxidants from sustainable sources are favoured to accommodate worldwide antioxidant demand. In addition to bioprospecting for natural and sustainable antioxidant sources, this study aimed to investigate the relationship between the bioactives (i.e. carotenoid and phenolic acids) and the antioxidant capacities in fucoxanthin-producing algae. Total carotenoid, phenolic acid, fucoxanthin contents and fatty acid profile of six species of algae (five microalgae and one macroalga) were quantified followed by bioactivity evaluation using

four antioxidant assays. Chaetoceros calcitrans and Isochrysis galbana displayed the highest antioxidant activity, followed by Odontella sinensis and Skeletonema costatum which showed moderate bioactivities. Phaeodactylum tricornutum and Saccharina japonica exhibited the least antioxidant activities amongst the algae species examined. Pearson correlation and multiple linear regression showed that both carotenoids and phenolic acids were significantly correlated (p<0.05) with the antioxidant activities, indicating the influence of these bioactives on the algal antioxidant capacities.

Interactive effects of PAHs and heavy metal mixtures on oxidative stress in Chlorella sp. MM3 as determined by artificial neural network and genetic algorithm

Fecha de Publicación: Enero 2017
Fuente: Algal Research, Volume 21
Autores: Suresh R. Subashchandrabose, Liang Wang, Kadiyala Venkateswarlu, Ravi Naidu, Mallavarapu Megharaj
Abstract

Mixture toxicity studies are very complex due to the complexity exhibited by the chemicals involved, and the net interaction effects are highly dependent on mixture combinations, exposure dose and the test organism. For assessing the toxicity of mixtures, factorial analysis has been widely used, while the usage of models developed by artificial neural network (ANN) analysis and genetic algorithm (GA) is very limited. We combined for the first time the factorial design experiment with ANN and GA to develop a model for predicting the interactive toxicological effects using a soil microalga, Chlorella sp. MM3. The chemicals included in the mixtures were two polyaromatic hydrocarbons (PAHs), phenanthrene and benzo[a]pyrene, and two heavy metals (HMs), cadmium and lead. Three biochemicals implicated in oxidative stress, viz., malondialdehyde (a measure for lipid peroxidation, LPO), catalase activity and proline accumulation were used as the toxicity criteria. Validation of the predicted results related to the biochemicals with the experimental data clearly indicated that the model developed with the combination of ANN and GA is greatly effective in predicting the toxicity of PAHs and HMs mixtures toward microalga with <10% relative error. Both catalase and LPO were found to be the promising biomarkers for predicting microalgal toxicity of PAHs and HMs mixtures. In addition, a significant positive correlation was evident between the removal of PAHs/uptake of HMs and LPO.

Intraspecific trait variation affecting astaxanthin productivity in two Haematococcus (Chlorophyceae) species

Fecha de Publicación: Enero 2017
Fuente: Algal Research, Volume 21
Autores: Céline C. Allewaert, Pieter Vanormelingen, Ilse Daveloose, Tine Verstraete, Wim Vyverman
Abstract

Microalgae are increasingly used as commercial sources of high-value compounds. However, the nature and genetic basis of variation in commercially relevant traits remain understudied. This study focuses on the green alga Haematococcus pluvialis, well-known for accumulating the carotenoid astaxanthin. We examined intra- and interspecific variation and correlations between six traits related to astaxanthin productivity among 30 natural isolates and cultivated strains of two Haematococcus species. Significant intraspecific genotypic variation was found for all traits assessed in both species (broad sense heritability estimates H^2 =0.48–0.89), resulting in a fifteen-fold variation in astaxanthin productivity between the poorest and the best-performing strain. The two species differed in five of the six traits. Cultivated strains had a lower astaxanthin productivity compared to natural isolates of H. pluvialis, possibly reflecting loss of photoprotective capacity during long-term cultivation. In general, trait correlations were weak yet stronger in H. rubicundus than in H. pluvialis. Most of the variation in overall astaxanthin productivity could be explained by the differences in post-stress traits. Our results reveal extensive trait variation among isolates of a commercially interesting microalga. We recommend natural strain panels as a valuable tool for cost-efficient trait mapping and to select targets for genetic engineering, marker-assisted strain selection or breeding aiming at the optimization of astaxanthin productivity.

Structural changes of Arthrospira sp. after low energy sonication treatment for microalgae harvesting: Elucidating key parameters to detect the rupture of gas vesicles

Fecha de Publicación: Enero 2017
Fuente: Bioresource Technology, Volume 223
Autores: Martí Lecina, Benjamin Sanchez, Carles Solà, Jordi Prat, Mònica Roldán, Mariona Hernández, Ramon Bragós, Carlos J. Paredes, Jordi J. Cairó
Abstract

The buoyancy suppression by low energy sonication (LES) treatment ($0.8W{\cdot}mL^{-1}$, 20kHz, 10s) has recently been proposed as an initial harvesting step for Arthrospira sp. This paper aims to describe the structural changes in

Arthrospira sp. after LES treatment and to present how these structural changes affect the results obtained by different analytical techniques. Transmission electron microscopy (TEM) micrographs of trichomes evidenced the gas vesicles rupture but also revealed a rearrangement of thylakoids and more visible phycobilisomes were observed. Differences between treated and untreated samples were detected by confocal microscopy, flow cytometry and optical microscopy but not by electrical impedance spectroscopy (EIS). After LES treatment, 2-fold increase in autofluorescence at 610/660nm was measured (phycocyanin/allophycocyanin emission wavelengths) and a ten-fold decrease in side scatter light intensity (due to a reduction of trichome's inner complexity). This was further confirmed by optical microscopy showing changes on trichomes appearance (from wrinkled to smooth).

Algae as Crops Seaweed

Fecha de Publicación: 2017
Fuente: Encyclopedia of Applied Plant Sciences, Volume 3
Autores: P.D. Kerrison
Abstract

Seaweeds come in a vast array of forms, colors, and chemical compositions. This variety has allowed their use for food, fodder, soil improvement, horticulture, and the extraction of gelling agents and other chemicals used in industrial processes. Some are also promising candidates for third-generation biofuel production. Natural stocks are insufficient to meet this demand, and so cultivation in both land-based tanks and at sea has rapidly expanded, now estimated to cover 750000ha. This article described the many uses of seaweed and the variety of cultivation methodologies that have been developed using the examples of Eucheuma and Kappaphycus, Ulva, the kelps including Saccharina japonica, and finally Porphyra.

Screening of marine microalgae isolated from the hypersaline Bardawil lagoon for biodiesel feedstock

Fecha de Publicación: Febrero 2017
Fuente: Renewable Energy, Volume 101
Autores: Abd El-Fatah Abomohra, Mostafa El-Sheekh, Dieter Hanelt
Abstract

Recently, microalgae have been attracting a wide attention as a source of high-lipid feedstock to produce biodiesel. A total of twenty one halophilic microalgae were isolated from the hypersaline Bardawil lagoon North Sinai, Egypt. Nine of

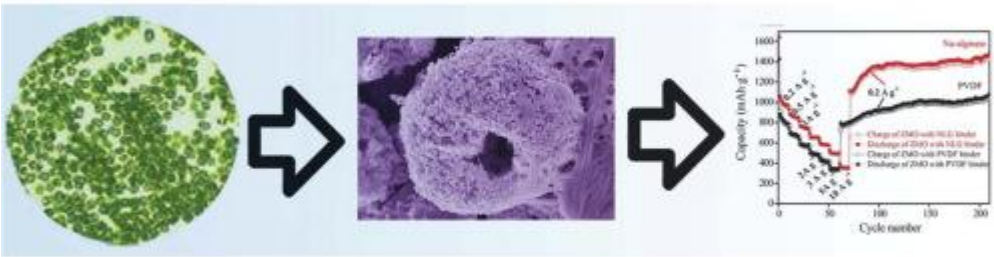
them were further characterized with respect to biomass and fatty acid productivities. Biomass productivity as cellular dry weight (CDW), fatty acid content and, consequently, fatty acid productivity of the chlorophyte Tetraselmis elliptica was the highest among alltested strains (0.122 g CDW L^{-1} d^{-1}, 77.36 mg g^{-1} CDW and 14.1 mg L^{-1} d^{-1}, respectively). Lipid fractionation showed that total lipids represented 12.96 mg g^{-1} CDW and neutral lipids represented 37% of the total lipids with corresponding iodine value of 70.3 g I2/100 g oil. In all fractions, C16:0 and C18:1n-9 were predominant, being as high as 31 and 20% of total fatty acids in neutral lipids, 26 and 24% of total fatty acids in polar lipids and 28 and 26% of total fatty acids in phospholipids, respectively. This study demonstrates that the halophilic microalga T. elliptica isolated from hypersaline water is a promising species for biodiesel feedstock.

Marine microalgaes-derived porous ZnMn2O4/C microspheres and performance evaluation as Li-ion battery Anode by using different binders

Fecha de Publicación: 15 Enero 2017
Fuente: Chemical Engineering Journal, Volume 308
Autores: Jiaxin Chen, Wei Liu, Shuang Liu, Huanlei Wang, Yuan Zhang, Shougang Chen
Abstract

The shortage in energy has given rise to the development of biomass as advanced energy materials. As a by-product of microalgae biofuel, a large amount of residual broken microalgaes have an urgent requirement to be utilized by an environmentally friendly and economically feasible technology. In this paper, we reported that a hierarchically porous ZnMn2O4/biocarbon (ZMO/BC) microsphere fabricated via the residual broken microalgaes as templates, which can be applied as the electrode materials of lithium-ion batteries. Based on the hierarchical porosity and the unique nanocapsules-like biocarbon structure formed in cycling, the ZMO/BC composites exhibited a superior electrochemical property. More attractively, the electrodes of such materials with Na-alginate as binder (also derived from algaes) exhibited the highest ever capacity, superior rate performance and the excellent long-term cycling stability.

Graphical abstract



Microalgal cultivation using aquaculture wastewater: Integrated biomass generation and nutrient remediation

Fecha de Publicación: Enero 2017
Fuente: Algal Research, Volume 21
Autores: Faiz Ahmad Ansari, Poonam Singh, Abhishek Guldhe, Faizal Bux
Abstract

Microalgal cultivation using aquaculture wastewater is a promising biorefinary concept for integrated biomass generation and subsequent nutrient removal. In this study, potential of aquaculture wastewater (AWW) as a nutrient substrate for cultivation of Scenedesmus obliquus, Chlorella sorokiniana and Ankistrodesmus falcatus was investigated. Nutrient removal efficiencies were also investigated for selected microalgal strains. Sodium nitrate supplementation strategy is applied to enhance the productivities of biomass, lipid, carbohydrate and protein. Biomass productivities of A. falcatus (198.46mgL^{-1} d^{-1}) with 400mgL^{-1} sodium nitrate supplementation and C. sorokiniana (157.04mgL^{-1} d^{-1}) with 600mgL^{-1} sodium nitrate supplementation in AWW were comparable to the synthetic medium. Comparable lipid, carbohydrates and proteins productivities were observed in microalgal biomass cultivated using AWW to the productivities in the synthetic medium. Microalgal cultivation in AWW showed removal efficiencies in the range of 86.45–98.21% for ammonia, 75.76–80.85% for nitrate, 98.52–100% for phosphate and 42–69% for COD.

Hydrothermal liquefaction of Cyanidioschyzon merolae and the influence of catalysts on products

Fecha de Publicación: Enero 2017
Fuente: Bioresource Technology, Volume 223

Autores: Tapaswy Muppaneni, Harvind K. Reddy, Thinesh Selvaratnam, Kodanda Phani Raj Dandamudi, Barry Dungan, Nagamany Nirmalakhandan, Tanner Schaub, F. Omar Holguin, Wayne Voorhies, Peter Lammers, Shuguang Deng

Abstract

This work investigates the hydrothermal liquefaction (HTL) of Cyanidioschyzon merolae algal species under various reaction temperatures and catalysts. Liquefaction of microalgae was performed with 10% solid loading for 30min at temperatures of 180–300°C to study the influences of two base and two acid catalysts on HTL product fractions. Maximum biocrude oil yield of 16.98% was obtained at 300°C with no catalyst. The biocrude oil yield increased to 22.67% when KOH was introduced into the reaction mixture as a catalyst. The algal biocrude and biochar has a higher heating values (HHV) of 32.22MJkg^{-1} and 20.78MJkg^{-1} respectively when no catalyst was used. Gas chromatography time of flight mass spectrometry (GC/TOFMS) was employed to analyze the biocrude oil composition, and elemental analysis was performed on the algae, biocrude and biochar samples. Analysis of the HTL aqueous phase revealed the presence of valuable products.

Graphical abstract

Re-express hydrothermal liquefaction bio-crude in petroleum way

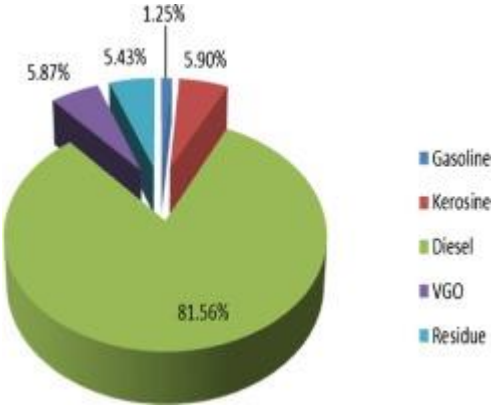
Fecha de Publicación: 1 Marzo 2017
Fuente: Fuel, Volume 191
Autores: Sheng Fu, Jie Yang, Ming Shi, Dongmei Wei, Hong Yin, Jinsheng Sun, Jie He

Abstract

Bio-crude obtained from algae by hydrothermal liquefaction (HTL), is considered to be one of the major emerging fuel feedstocks and, as such, has drawn considerable attention from a number of researchers. However, its complex composition has stifled the development of this material in the effort to utilize it as a replacement for conventional petroleum transportation fuels. In addition, the high nitrogen content of the algal-based crude oil presents a high NOx emission risk during its combustion. Characterization of this crude product is important for defining the separation of the material and in defining its reactions in the areas of fuel production and denitrification. This work attempted to define the bio-crude using conventional petroleum industry metrics by replacing

pseudo-components with real components. Specifically, the true boiling point (TBP) curve of the bio-crude oil was established using actual GC–MS results and thermogravimetric analyses (TGA). This current combination of analyses represents an inconvenient method for defining the TBP of bio-crude oil. The approach entailed using commercial process simulators to interpret accumulative TGA results as a mass-based TBP curve data input. Then, instead of generating pseudo-components through built-in mathematical methods, typical (or specific) real components of the cascade TBPs were selected from the GC–MS results to form a discrete TBP curve. This new curve provided a component table that included typical, but limited, real components. A simulation of the distillation process was then conducted to characterize the composition of the bio-crude and the distribution of nitrogen in the distillate cuts. The diesel fraction in the simulated distillation of the bio-crude sample accounted for the largest fraction and the nitrogen content was evenly distributed between the fractions which were obtained by separation methods.

Graphical abstract



Environmental stressors and lipid production by Dunaliella spp. I. Salinity

Fecha de Publicación: Febrero 2017
Fuente: Journal of Experimental Marine Biology and Ecology, Volume 487
Autores: Stephanie Mixson Byrd, JoAnn M. Burkholder, Paul V. Zimba
Abstract

Fourteen strains within four species of the marine chlorophyte genus, Dunaliella were assessed for their potential utility in sustainable biofuel production by tracking lipid production under salinity stress. A modified technique with Nile Red stain was used to screen cultures rapidly for the presence of neutral lipid content. Promising strains with visually high lipid content and high growth as cell production were selected to enhance lipid production using high salinity (hyperosmotic) stress in short-term (s to h) and long-term (≥24h) bench-scale

experiments (culture volume 0.1 to 3.5L). These strains were also grown at mass culture scale (culture volume~150 to 175L). The difference in experimental scale was imposed because of the container effects shown for various algae, and in recognition of the importance of scale-up feasibility in harnessing algae for biofuel production. Saponifiable lipids were converted to fatty acid methyl esters, here referred to as total fatty acids (FAs), by direct transesterification. High salinity stress generally resulted in maximal total fatty acid (FA) content (up to 65% by dry weight) in comparison to controls (~10–25% total FAs by dry weight). Glycerol production, a known mechanism of osmoregulation in Dunaliella, was measured in a short-term salinity stress experiment on a promising strain and found to increase significantly 30min to 24h after exposure to high salinity. Quantitative reverse transcription polymerase chain reaction (RT-qPCR) was used to evaluate the relative expression of glyceryl-3-phosphate dehydrogenase (GPDH), one of the primary glycerol biosynthesis genes for glycerol production, during a short-term experiment with high salinity stress. GPDH was significantly expressed (≥2-fold when compared to the endogenous gene ACTIN) 30min after exposure and continued to be expressed for 2h. In general, when cellular glycerol content was low, total FAs increased as an immediate or short-term response (30s to 30min) to hyperosmotic stress. Responses were strain-specific and indicated both inter- and intraspecific variation. Overall, a simple high salinity adjustment significantly increased lipid production in selected strains of Dunaliella spp. The data suggest that these Dunaliella strains may incorporate a portion of the available glycerol as triacylglycerols (TAGs) or neutral lipids under short-term high salinity stress.

Potential of seaweed as a feedstock for renewable gaseous fuel production in Ireland

Fecha de Publicación: Febrero 2017
Fuente: Renewable and Sustainable Energy Reviews, Volume 68, Part 1
Autores: Muhammad Rizwan Tabassum, Ao Xia, Jerry D. Murphy
Abstract

Resource depletion and mitigation of climate change are the driving forces to find alternatives to fossil fuels. Seaweeds (macroalgae) have been considered as a promising alternative source of biofuels due to higher growth rates, greater production yields and a higher rate of carbon dioxide fixation, than land crops. A comparatively easily depolymerized structure, lack of need of arable land and no fresh water requirement for cultivation, make seaweed a potential feedstock for gaseous biofuel production. Biomethane potential of seaweed is greatly dependent on its chemical composition that is highly variable due to its type, habitat, cultivation method and time of harvest. Saccharina latissima and Laminaria digitata are the highest biomethane yielding Irish brown seaweeds. Seaweed harvested in July (northern hemisphere) was estimated to give gross

energy yields in the range 38–384 GJ ha^{-1} yr^{-1}; higher values are dependent on innovative cultivation systems. An integrated model is suggested where seaweed can be co-digested with other feedstock for the sustainable production of gaseous fuel to facilitate EU renewable energy targets in transport.

Microbial bioelectrosynthesis of hydrogen: Current challenges and scale-up

Fecha de Publicación: Enero 2017
Fuente: Enzyme and Microbial Technology, Volume 96
Autores: Michael Kitching, Robin Butler, Enrico Marsili
Abstract

Sustainable energy supplies are needed to supplement and eventually replace fossil fuels. Molecular hydrogen H2 is a clean burning, high-energy fuel that is also used as reducing gas in industrial processes. H2 is mainly synthesized by steam reforming of natural gas, a non-renewable fuel. There are biosynthetic strategies for H2 production; however, they are associated with poor yield and have high cost. The application of an electrochemical driving force in a microbial electrolysis cell (MEC) improves the yield of biological reactions. The performance of the MEC is influenced by experimental parameters such as the electrode material, reactor design, microbial consortia and the substrate. In this review, factors that affect the performance of MECs are discussed and critically analysed. The potential for scale-up of H2 bioelectrosynthesis is also discussed.

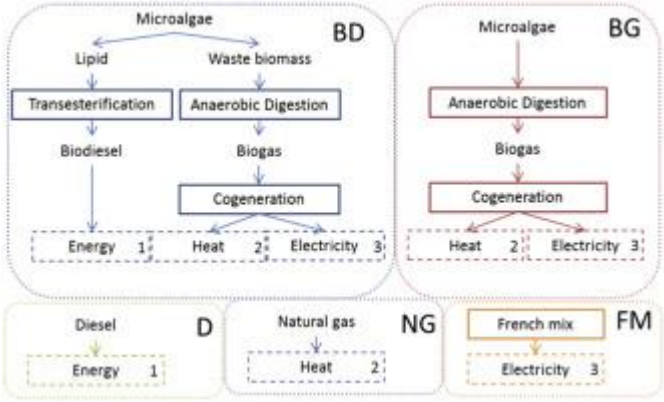
Environmental assessment of bioenergy production from microalgae based systems

Fecha de Publicación: 15 Diciembre 2016
Fuente: Journal of Cleaner Production, Volume 139
Autores: Allan Hayato Shimako, Ligia Tiruta-Barna, Yoann Pigné, Enrico Benetto, Tomás Navarrete Gutiérrez, Pascal Guiraud, Aras Ahmadi
Abstract

Microalgae have been studied as a potential alternative raw material and various technologies have been proposed to transform the algal biomass into energy products. In this study, two bioenergy production systems of very different complexities were modelled to assess their environmental efficiencies: a biodiesel system and a biogas system. Biodiesel system used supercritical extraction and transesterification as key processes; to the best of authors' knowledge, there is no previous work analysing the environmental

performances of such production system. Cumulative energy demand, Life Cycle Assessment (LCA) and dynamic LCA for climate change were used to evaluate the environmental footprint of the production systems. Conventional systems for electricity, heat and diesel production were considered for comparison. Energy balance showed that the supercritical extraction and drying steps were the most energy consuming unit operations in biodiesel production and further developments of technologies might be envisaged. LCA showed that climate change was the main contributor to impacts on human health and ecosystem quality due to energy consumed in production steps. Also, heat from biogas was the only product that proved to have a satisfactory environmental performance with regard to other conventional production systems. Finally, dynamic climate change evaluation (used for the first time for bio-chemical processes) revealed no carbon sequestration in microalgae system.

Graphical abstract



Energy performance and greenhouse gas emissions of kelp cultivation for biogas and fertilizer recovery in Sweden

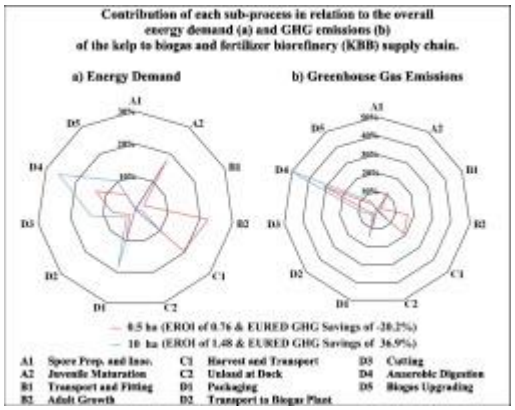
Fecha de Publicación: 15 Diciembre 2016
Fuente: Science of The Total Environment, Volume 573
Autores: Joseph S. Pechsiri, Jean-Baptiste E. Thomas, Emma Risén, Mauricio S. Ribeiro, Maria E. Malmström, Göran M. Nylund, Anette Jansson, Ulrika Welander, Henrik Pavia, Fredrik Gröndahl

Abstract

The cultivation of seaweed as a feedstock for third generation biofuels is gathering interest in Europe, however, many questions remain unanswered in practise, notably regarding scales of operation, energy returns on investment (EROI) and greenhouse gas (GHG) emissions, all of which are crucial to determine commercial viability. This study performed an energy and GHG emissions analysis, using EROI and GHG savings potential respectively, as indicators of commercial viability for two systems: the Swedish Seafarm project's seaweed cultivation (0.5ha), biogas and fertilizer biorefinery, and an

estimation of the same system scaled up and adjusted to a cultivation of 10ha. Based on a conservative estimate of biogas yield, neither the 0.5ha case nor the up-scaled 10ha estimates met the (commercial viability) target EROI of 3, nor the European Union Renewable Energy Directive GHG savings target of 60% for biofuels, however the potential for commercial viability was substantially improved by scaling up operations: GHG emissions and energy demand, per unit of biogas, was almost halved by scaling operations up by a factor of twenty, thereby approaching the EROI and GHG savings targets set, under beneficial biogas production conditions. Further analysis identified processes whose optimisations would have a large impact on energy use and emissions (such as anaerobic digestion) as well as others embodying potential for further economies of scale (such as harvesting), both of which would be of interest for future developments of kelp to biogas and fertilizer biorefineries.

Graphical abstract



Evaluation of different pretreatments on organic matter solubilization and hydrogen fermentation of mixed microalgae consortia

Fecha de Publicación: 14 Diciembre 2016
Fuente: International Journal of Hydrogen Energy, Volume 41, Issue 46
Autores: Gopalakrishnan Kumar, Periyasamy Sivagurunathan, Ngoc Bao Dung Thi, Guangyin Zhen, Takuro Kobayashi, Sang-Hyoun Kim, Kaiqin Xu
Abstract

This study investigated the effects of pretreatment methods (such as autoclave, ultrasonication and electrolysis) of mixed microalgae consortia (predominantly composed of Scenedesmus followed by Chlorella species) from natural ecological niche. In addition, the cultivated biomass (wet) was subsequently utilized for fermentative H2 production in mesophilic regime. The results showed that peak hydrogen production rate (HPR) and hydrogen yield (HY) were achieved from electrolysis pretreated algal consortia as 236 ± 14 mL/L-d and 37.7 ± 0.4 mL/g (volatile solids) VSadded, whereas the untreated algal consortia resulted in the

turnout as 64 ± 5 mL/L-d and 9.5 ± 0.0 mL/g VSadded, respectively. The significant increment observed in HPR and HY values were nearly 4 times higher. The solubilization of organic matter during the pretreatment showed positive correlation with the H2 production. The energy generation rate and yield of the corresponding pretreatment methods were as follows, 1.44, 1.79 and 2.65 kJ/L-d for autoclave, ultra-sonication and electrolysis, the corresponding yields also fell in the range of 0.32, 0.41 and 0.43 kJ/g VSadded, respectively.

PATENTES

Culture method for improving oil production of microalgae

Page bookmark	CN105331646 (A) - Culture method for improving oil production of microalgae
Inventor(s):	XUE SONG; WU SHUANG; CAO XUPENG; ZHOU JIANNAN; WU PEICHUN; WANG XI + (XUE SONG, ; WU SHUANG, ; CAO XUPENG, ; ZHOU JIANNAN, ; WU PEICHUN, ; WANG XI)
Applicant(s):	DALIAN CHEMICAL PHYSICS INST + (DALIAN INSTITUTE OF CHEMICAL PHYSICS, CHINESE ACADEMY OF SCIENCES)

Abstract of CN105331646 (A)

The invention discloses a culture method for improving oil production of microalgae. By adding hydrogen peroxide (H2O2) with final concentration being 0.35-12mM to a microalgae culture medium, microalgae grease is rapidly accumulated. The concentration range of the H2O2 is effective to microalgae which is 0.1-16.37cells/mL in cell concentration. The method can shorten a culture cycle and reduce production cost. The method disclosed by the invention, which uses the low-concentration H2O2 as a microalgae grease accumulation inducing agent, is low in H2O2 using dosage, environment-friendly, convenient to operate and significant in effect, and is suitable for the oil production large-scale culture of the microalgae.

Low-carbon zero-discharge method used for producing hydrogen

Page bookmark	CN105713949 (A) - Low-carbon zero-discharge method used for producing hydrogen
Inventor(s):	SU HUIBO; CHENG JUN; ZHOU JUNHU; CEN KEFA; LIN HAILONG + (SU HUIBO, ; CHENG JUN, ; ZHOU JUNHU, ; CEN KEFA, ; LIN HAILONG)
Applicant(s):	COFCO CORP; COFCO NUTRITION & HEALTH RES INST CO LTD + (COFCO CORPORATION, ; COFCO NUTRITION AND HEALTH RESEARCH INSTITUTE CO., LTD)

Abstract of CN105713949 (A)
The invention provides a low-carbon zero-discharge method used for producing hydrogen. In the low-carbon zero-discharge method, microalgae biomass is taken as a fermentation substrate. The low-carbon zero-discharge method comprises following steps: 1, pretreatment of microalgae biomass, 2, dark fermentation hydrogen production, 3, photo fermentation hydrogen production, and 4, hydrogen purification and microalgae cultivation. The low-carbon zero-discharge method is high in hydrogen yield, hydrogen production rate, substrate utilization ratio, and energy conversion rate; ad discharge of greenhouse gases is reduced, and circulating supply of the hydrogen production substance is realized at the same time.

PROCESS OF PRODUCTION OF OIL FROM MICROALGAE.

Page bookmark MX2015016953 (A) - PROCESS OF PRODUCTION OF OIL FROM MICROALGAE.
Inventor(s): CANEPA PIETRO [IT] + (PIETRO CANEPA)
Applicant(s): BIO TE MA S R L [IT] + (BIO.TE.MA. S.R.L)
Abstract of MX2015016953 (A)

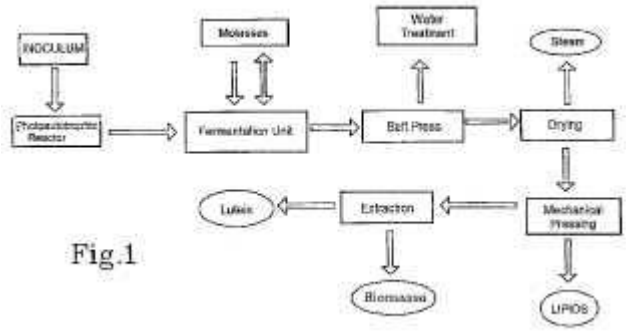


Fig.1

The invention relates to a process for the production of lipids (oil) from microalgae, comprising the cultivation of microalgae by sequential photoautotrophic-heterotrophic growth, wherein in the heterotrophic step the microalgae are fed by administration of a sugar feed deriving from sugar production waste, for example molasses or bagasse, or else deriving from waste from the fruit candying industry, for example candying water, which has a sugar content comprised between 20% and 60% by weight. The invention also relates to a plant for the production of lipids (oil) from microalgae, intended for carrying out the process of the invention.

MICROALGAE CHLAMYDOMONAS SP. ARM0029C STRAIN PRODUCING LIPID AND USES THEREOF

Page bookmark	KR101601119 (B1) - MICROALGAE CHLAMYDOMONAS SP. ARM0029C STRAIN PRODUCING LIPID AND USES THEREOF
Inventor(s):	CHOI HAN GU [KR]; HAN SE JONG [KR]; KIM SANG HEE [KR]; KANG SUNG HO [KR]; JUNG WOONG SIC [KR]; KIM EUN JAE [KR]; LIM SU YOUN [KR] + (CHOI, HAN GU, ; HAN, SE JONG, ; KIM, SANG HEE, ; KANG, SUNG HO, ; JUNG, WOONG SIC, ; KIM, EUN JAE, ; LIM, SU YOUN)
Applicant(s):	KOREA INST OCEAN SCI & TECH [KR] + (KOREA INSTITUTE OF OCEAN SCIENCE & TECHNOLOGY)

Abstract of KR101601119 (B1)
The present invention relates to the genus Chlamydomonas ArM0029C (Chlamydomonas sp. ArM0029C), which is microalgae having lipid productivity and, more specifically, to the microalgae of the genus Chlamydomonas ArM0029C derived from the North pole, which can be used for producing functional lipids and biodiesel at low temperatures, and to uses thereof. According to the present invention, the microalgae of the genus Chlamydomonas ArM0029C derived from the North pole is capable of accumulating lipids with different carbon numbers at low temperatures, and can be used for producing functional lipids and biodiesel during winter time. In addition, cells are killed, when being cultured at high temperatures. Therefore, the microalgae can be efficiently used for preventing environmental destruction caused by foreign species in the case of culturing in the open ground.

MICROALGAE CHLAMYDOMONAS SP. ARF0008 STRAIN PRODUCING LIPID AND USES THEREOF

Page bookmark	KR101601118 (B1) - MICROALGAE CHLAMYDOMONAS SP. ARF0008 STRAIN PRODUCING LIPID AND USES THEREOF
Inventor(s):	HAN SE JONG [KR]; CHOI HAN GU [KR]; KIM SANG HEE [KR]; JUNG WOONG SIC [KR]; KIM EUN JAE [KR]; LIM SU YOUN [KR] + (HAN, SE JONG, ; CHOI, HAN GU, ; KIM, SANG HEE, ; JUNG, WOONG SIC, ; KIM, EUN JAE, ; LIM, SU YOUN)
Applicant(s):	KOREA INST OCEAN SCI & TECH [KR] + (KOREA INSTITUTE OF OCEAN SCIENCE & TECHNOLOGY)

Abstract of KR101601118 (B1)
The present invention relates to the genus Chlamydomonas ArF0008 (Chlamydomonas sp. ArF0008), which is microalgae having lipid productivity and, more specifically, to the microalgae of the genus Chlamydomonas ArF0008 derived from the North pole, which can be used for producing functional lipids and biodiesel at low temperatures, and to uses thereof. According to the present

invention, the microalgae of the genus Chlamydomonas ArF0008 derived from the North pole is capable of accumulating lipids with different carbon numbers at low temperatures, and can be used for producing functional lipids and biodiesel during winter time. In addition, cells are killed, when being cultured at high temperatures. Therefore, the microalgae can be efficiently used for preventing environmental destruction caused by foreign species in the case of culturing in the open ground.

Tailored oils produced from recombinant oleaginous microorganisms

Page bookmark	AU2016247159 (A1) - Tailored oils produced from recombinant oleaginous microorganisms
Inventor(s):	FRANKLIN SCOTT; SOMANCHI ARAVIND; WEE JANICE; RUDENKO GEORGE; MOSELEY JEFFREY; RAKITSKY WALT; ZHAO XINHUA; BHAT RIYAZ + (Franklin, Scott, ; Somanchi, Aravind, ; Wee, Janice, ; Rudenko, George, ; Moseley, Jeffrey, ; Rakitsky, Walt, ; Zhao, Xinhua, ; Bhat, Riyaz)
Applicant(s):	TERRAVIA HOLDINGS INC + (TerraVia Holdings, Inc)

Abstract of AU2016247159 (A1)
Methods and compositions for the production of oil, fuels, oleochemicals, and other compounds in recombinant microorganisms are provided, including oil-bearing microorganisms and methods of low cost cultivation of such microorganisms. Microalgal cells containing exogenous genes encoding, for example, a lipase, a sucrose transporter, a sucrose invertase, a fructokinase, a polysaccharide-degrading enzyme, a keto acyl-ACP synthase enzyme, a fatty acyl-ACP thioesterase, a fatty acyl-CoA/aldehyde reductase, a fatty acyl-CoA reductase, a fatty aldehyde reductase, a fatty acid hydroxylase, a desaturase enzyme, a fatty aldehyde decarbonylase, and/or an acyl carrier protein are useful in manufacturing transportation fuels such as renewable diesel, biodiesel, and renewable jet fuel, as well as oleochemicals such as functional fluids, surfactants, soaps and lubricants.

BIOREMEDIACION

PUBLICACIONES

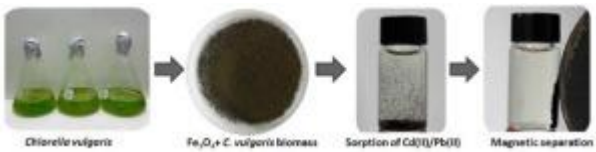
Insight into the mechanism of Cd(II) and Pb(II) removal by sustainable magnetic biosorbent precursor to Chlorella vulgaris

Fecha de Publicación: Disponible online 26 Diciembre 2016
Fuente: Journal of the Taiwan Institute of Chemical Engineers
Autores: Lalhmunsiama, Prabuddha L. Gupta, Hyunhoon Jung, Diwakar Tiwari, Sung-Ho Kong, Seung-Mok Lee

Abstract

Iron oxide nanoparticles were impregnated with the Chlorella vulgaris (CV) microalgae in order to obtain the magnetic biomaterial (magnetic-CV). The materials were characterized by SEM-EDX, HR-TEM, FT-IR and XPS analyses. Further, the magnetic-CV was successfully employed in the removal of Cd(II) and Pb(II) from aqueous solutions. High percentage uptakes of these two toxic ions were observed in a wide range of pH and initial sorbate concentrations. The material was found to be efficient in the rapid uptake of Cd(II)/Pb(II) from aqueous solutions. The increases in background electrolyte concentrations (i.e., 0.001−0.1mol/L NaNO3) affected the uptake of Cd(II) to a greater extent whereas Pb(II) removal was almost unaffected. This implied that Cd(II) was sorbed with weaker forces whereas the Pb(II) ions were aggregated specifically onto the solid surface forming an inner sphere complexes. Moreover, a simultaneous sorption study inferred that Cd(II) and Pb(II) were sorbed at the different binding sites available at the hybrid biomaterial. Furthermore, the sorption mechanism discussed with FT-IR and XPS analyses has shown that Cd(II) bound with weak electrostatic forces to the dissociated carboxyl or hydroxyl groups available onto the solid surface whereas Pb(II) ions were chemically bound with the amino group of magnetic-CV.

Graphical abstract



Membrane bioreactors – A review on recent developments in energy reduction, fouling control, novel configurations, LCA and market prospects

Fecha de Publicación: Disponible online 10 Diciembre 2016
Fuente: Journal of Membrane Science
Autores: Pawel Krzeminski, Lance Leverette, Simos Malamis, Evina Katsou
Abstract

Membrane bioreactor (MBR) technology is considered a well-established, mature technology with many full-scale plants around the world treating municipal and industrial wastewater. However, membrane fouling and energy consumption still remain serious obstacles and challenges in the wider spread of the MBR technology. Therefore, considerable research and development efforts are still underway. Recent developments are primarily focused on aspects related to energy reduction, fouling control and novel configurations for enhanced process performance. This review addresses the recent work on the above mentioned aspects and it discusses the overall life cycle of MBRs and the market prospects for MBR technology. Novel MBR configurations and integrations with other technologies are also reviewed. Finally, the challenges that need to be addressed in order to facilitate market penetration of MBR technology are highlighted.

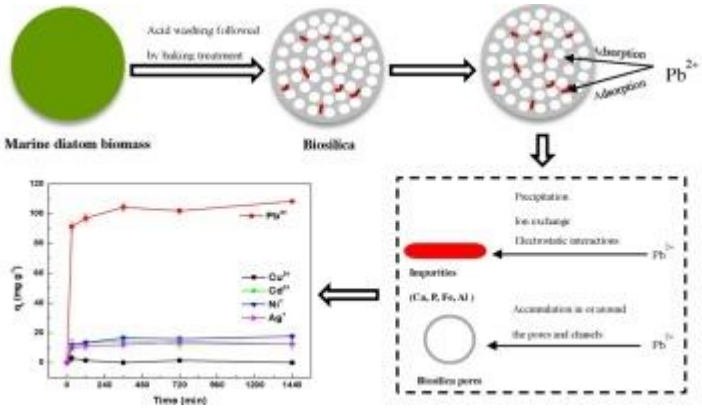
Selective adsorption of Pb(II) from aqueous solution using porous biosilica extracted from marine diatom biomass: Properties and mechanism

Fecha de Publicación: 28 Febrero 2017
Fuente: Applied Surface Science, Volume 396
Autores: Yarong Qi, Jingfeng Wang, Xin Wang, Jay Jiayang Cheng, Zhiyou Wen
Abstract

Biosilica with a surface area of 143m^2 g^{-1} derived from marine diatoms was prepared using an easy two-step method involving washing with dilute acid and baking. The extracted biosilica was used to remove divalent lead ions, i.e., Pb(II), from aqueous solution. The effects on Pb(II) adsorption of initial pH, shaking speed, and adsorbent loading were investigated. The adsorption of Pb(II) in the presence of other ions was also investigated. The biosilica showed a high adsorption capacity with high selectivity for Pb(II). The experimental maximum

adsorption capacity was 108.2–120.4mgg^{-1} at an adsorbent loading of 1gL^{-1}. The adsorption process was best described by the Langmuir model. The adsorbent selectively adsorbed Pb(II) from binary ion systems in the presence of Cu(II), Cd(II), Ni(II), and Ag(I). The results of this study show that biosilica extracted from fresh marine diatoms is a more efficient and selective adsorbent for Pb(II) than other inorganic adsorbents.

Graphical abstract



Dual role of microalgae: Phycoremediation of domestic wastewater and biomass production for sustainable biofuels production

Fecha de Publicación: Octubre 2011
Fuente: Applied Energy, Volume 88, Issue 10
Autores: I. Rawat, R. Ranjith Kumar, T. Mutanda, F. Bux
Abstract

Global threats of fuel shortages in the near future and climate change due to green-house gas emissions are posing serious challenges and hence and it is imperative to explore means for sustainable ways of averting the consequences. The dual application of microalgae for phycoremediation and biomass production for sustainable biofuels production is a feasible option. The use of high rate algal ponds (HRAPs) for nutrient removal has been in existence for some decades though the technology has not been fully harnessed for wastewater treatment. Therefore this paper discusses current knowledge regarding wastewater treatment using HRAPs and microalgal biomass production techniques using wastewater streams. The biomass harvesting methods and lipid extraction protocols are discussed in detail. Finally the paper discusses biodiesel production via transesterification of the lipids and other biofuels such as biomethane and bioethanol which are described using the biorefinery approach.

Recovery of nutrients from swine wastewater using ultrafiltration: Applications for microalgae cultivation in photobioreactors

Fecha de Publicación: Septiembre 2016
Fuente: Ecological Engineering, Volume 94
Autores: Heather N. Sandefur, Maryam Asgharpour, Jason Mariott, Emily Gottberg, Jessica Vaden, Marty Matlock, Jamie Hestekin
Abstract

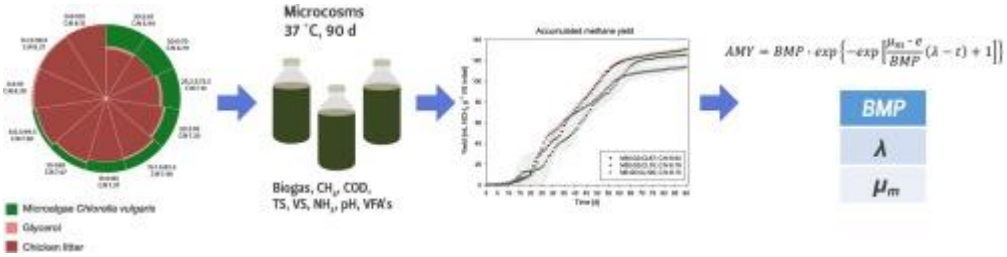
The large-scale production of microalgae poses a number of challenges, including a costly fertilizer demand. While wastewater provides a concentrated source of nutrients, the presence of biological contaminants and the expense of heat treatment are challenging for large-scale production. The goal of this study was to use ultrafiltration to purify wastewater for use in the cultivation of microalgae. Swine waste was filtered, and the resulting permeate was utilized in a Porphyridium cruentum culture. Fluxes remained relatively constant during operation, and the complete rejection of bacteria was observed. The permeate contained high concentrations of total nitrogen (695.6mgL^{-1}) and total phosphorus (69.1mgL^{-1}). Higher biomass productivity and lipid contents were observed in the microalgae cultivated in the waste medium compared to that of a control medium. This suggests that, by using ultrafiltration as an alternative to heat treatment, agricultural wastewaters could be utilized as a nutrient source for microalgae.

Biochemical methane potential of oil-extracted microalgae and glycerol in co-digestion with chicken litter

Fecha de Publicación: Enero 2017
Fuente: Bioresource Technology, Volume 224
Autores: José Carlos Meneses-Reyes, Guadalupe Hernández-Eugenio, David H. Huber, Nagamani Balagurusamy, Teodoro Espinosa-Solares
Abstract

The objective of this work was to evaluate the technical feasibility of using both oil-extracted microalgae (M) and glycerol (G) in co-digestion with chicken litter (CL), thereby improving biochemical methane potential (BMP). Different feedstock ratios of M (0–30%), G (0–3%) and CL (67–100%) were investigated to determine the best co-digestion condition under mesophilic conditions. According to the modified Gompertz model, the best BMP (131.1mLCH4 g VSfed - 1) was obtained with the triple co-digestion (M:G:CL) in a proportion of 30:3:67. This yielded a methane production rate (μm) of 3.3mLCH4 g VSfed - 1 d^{-1} and a lag time (λ) of 17.4d. This treatment reduced chemical oxygen demand (COD) by 91.02% and increased the methane yield 15.8% with respect to the CL control.

Graphical abstract

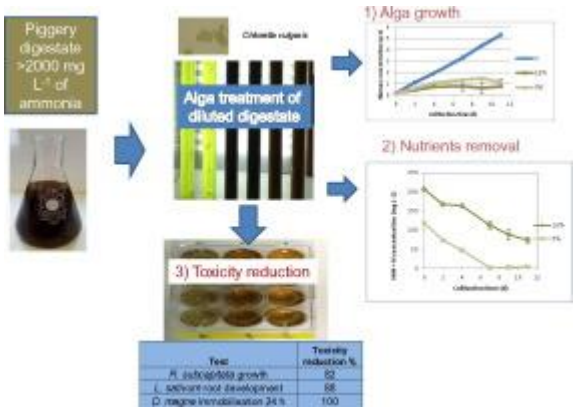


Microalgae treatment removes nutrients and reduces ecotoxicity of diluted piggery digestate

Fecha de Publicación: 1 Noviembre 2016
Fuente: Science of The Total Environment, Volumes 569–570
Autores:): Marta Franchino, Valeria Tigini, Giovanna Cristina Varese, Rocco Mussat Sartor, Francesca Bona
Abstract

Liquid digestate is considered as an important by-product of anaerobic digestion of agriculture wastes. Currently, it is very often directly spread on local agricultural land. Yet recently concerns on its environmental risk of this processing has begun to rise. On the other hand, investigations on the effectiveness of microalgae for wastewater treatment have started to consider also this complex matrix. In this study, we cultured the green alga Chlorella vulgaris in diluted digestate coming from the anaerobic digestion of pig slurry and corn, with the aim to significantly reduce its toxicity and its very high nutrient concentration. For this purpose, a battery of toxicity tests composed of four acute and two chronic bioassays was applied after the alga cultivation. Results were compared with those obtained in the initial characterization of the digestate. Results show that highly diluted piggery digestate can be a suitable medium for culturing microalgae, as we obtained a high removal efficiency (>90%) for ammonia, total nitrogen and phosphate, though after a few days phosphorus limitation occurred. Toxicity was significantly reduced for all the organisms tested. Possible solutions for optimizing this approach avoiding high dilution rates are discussed.

Graphical abstract



Nutrients utilization and contaminants removal. A review of two approaches of algae and cyanobacteria in wastewater

Fecha de Publicación: Disponible 5 Septiembre 2016
Fuente: Algal Research
Autores: Sara P. Cuellar-Bermudez, Gibran S. Aleman-Nava, Rashmi Chandra, J. Saul Garcia-Perez, Jose R. Contreras-Angulo, Giorgos Markou, Koenraad Muylaert, Bruce E. Rittmann, Roberto Parra-Saldivar

Abstract

The detection of new pollutants, stricter environmental regulations, and advancements in treatment technologies are driving improvements in bioprocesses for treating wastewater. Specifically, special concern is being placed on phosphorus and nitrogen forms, which spur eutrophication of water bodies, and emerging micropollutants such as pharmaceuticals and person-care products. Algae and cyanobacteria cultivation requirements include water and nutrient sources that currently are supplied by fertilizers, which provide poor sustainability and economics. Using wastewater as a source of nitrogen and phosphorus represents an attractive option to cultivate microalgae simultaneous with contaminant removal. Phycoremediation refers to the assimilation or disintegration of organic and inorganic compounds (carbon, nitrogen, or phosphorus), metals, and emerging contaminants in wastewater by microalgae – algae and cyanobacteria. In addition, added value comes when the microalgae are harvested to become feedstock for biofuels such as biogas. Although promising studies have been published for algal growth in wastewater while simultaneously removing contaminants, limitations in the scale-up process still have to be addressed. In this work, we summarize biological mechanisms by which nutrients and contaminants are removed by microalgae. We specifically address the interactions that the microalgae have with other microorganisms and the production of extracellular polymeric substances, a mechanism well

known in the literature, but hardly studied in microalgae. Finally, we discuss different strategies reported to improve the scale up of microalgae cultivation in wastewater.

Applying raw poultry litter leachate for the cultivation of Arthrospira platensis and Chlorella vulgaris

Fecha de Publicación: Enero 2016
Fuente: Algal Research, Volume 13
Autores: Giorgos Markou, Dimitris Iconomou, Koenraad Muylaert
Abstract

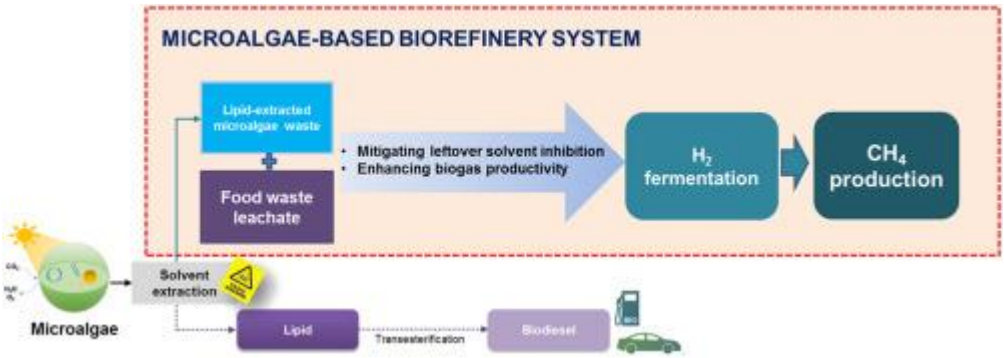
In the present paper, the use of raw poultry litter (PL) as a nutrient source for the cultivation of Arthrospira platensis and Chlorella vulgaris was investigated. PL was added to acid solution (62.5mM H2SO4) for the extraction of nutrients contained in PL. After settling, the supernatant, called PL leachate (PLL) was diluted 25×, 20×, 15×, and 10× and used as a medium for the cultivation of A. platensis and C. vulgaris. A. platensis could not survive in 15× and 10× diluted leachate and while in 20× and 25× dilutions the biomass production was only half of that in a control medium (Zarrouk). The biomass composition had a high carbohydrate content (37–44%), which suggests that A. platensis was stressed due to nutrient limitation. C. vulgaris grew well in PLL-based media and the biomass production was higher than in the control medium (BG-11). Biomass composition of C. vulgaris in PLL-based media had lower protein content and higher carbohydrate and lipid content than in the control medium. The overall process for producing microalgal biomass from PL that we propose includes: (i) acid extraction of nutrients through the generation of PL leachate (PLL), (ii) indoor PL composting and recovery of stripped ammonia and CO2, and (iii) use of recovered ammonia and CO2 along with the PLL for the cultivation of microalgae and cyanobacteria for the production of biomass.

Two-stage co-fermentation of lipid-extracted microalgae waste with food waste leachate: A viable way to reduce the inhibitory effect of leftover organic solvent and recover additional energy

Fecha de Publicación: 14 Diciembre 2016
Fuente: International Journal of Hydrogen Energy, Volume 41, Issue 46
Autores: Yeo-Myeong Yun, Shihwu Sung, June-Seok Choi, Dong-Hoon Kim
Abstract

This study aimed to mitigate the inhibitory effect of leftover organic solvent (CH3Cl, chloroform) on anaerobic digestion of lipid-extracted microalgae waste (LEMW). Food waste leachate (FWL) was added as a co-substrate and a two-stage fermentation process (H2 production with acidogenesis + methanogenesis) was adopted. The result of the first batch experiment, conducted in the absence of chloroform, showed that as the FWL addition ratio increased up to 60% on chemical oxygen demand (COD) basis, there was a gradual increase in the amount of H2 produced. At 80% addition, however, there was a huge drop in H2 yield, accompanied by a drop in pH. In the presence of chloroform (100–900 mg CH3Cl/L), the mixture (LEMW:FWL = 40:60) exhibited a much higher tolerance than that of LEMW alone, which could be ascribed to the co-metabolic degradation of chloroform by FWL addition. At 600 and 900 mg CHCl3/L, the degradation efficiency dropped below 40% for LEMW alone, while it was maintained above 90% in the mixture. A H2 yield of 36 mL H2/g COD, equivalent to 2.6% of the energy content in the feedstock, was attained from the mixture at 600 mg CHCl3/L. The H2 fermented effluent was then fed to a continuous methanogenic reactor at HRT 40 d, and 82% of energy content in the feedstock was further gained in the form of CH4. Although the energy gained from H2 production was negligible, most of the chloroform was degraded during acidogenesis, which resulted in a successful CH4 conversion.

Graphical abstract



Removal of nutrients from undiluted anaerobically treated piggery wastewater by improved microalgae

Fecha de Publicación: Diciembre 2016
Fuente: Bioresource Technology, Volume 222
Autores: Mingzi Wang, Yi Yang, Zhihong Chen, Yanzhen Chen, Yangmin Wen, Bilian Chen
Abstract

This study aimed at improving the adaptability and biodegradability of tested microalgae in undiluted anaerobic fermentation slurry of piggery wastewater. For that, a two-stage method based on UV irradiation followed by gradual domestication was developed. The distinctness of this method was the elimination of a screening procedure and just needed the UV-irradiated cells with appropriate survival to be subjected to gradual domestication. The microalgae treated with the method not only grew well in undiluted slurry, but achieved outstanding removal efficiencies in total nitrogen (TN) and total phosphorus (TP). Large-scale application was conducted in an open raceway pond, and the concentrations of TN and TP after treatment were 43.80mg/L (removal rate of 89.5%) and 5.83mg/L (removal rate of 85.3%) respectively, which greatly excelled the Chinese discharge standards for livestock and poultry wastewater. The strategy is therefore a promising method for microalgae to purify piggery slurry containing high nutrient contents.

Modelling the impacts of policies on advanced biofuel feedstocks diffusion

Fecha de Publicación: Disponible online 7 Noviembre 2016
Fuente: Journal of Cleaner Production
Autores: Lauro André Ribeiro, Patrícia Pereira da Silva, Leila Ribeiro, Fernando Luís Dotti
Abstract

This paper analyzes the market share penetration of advanced biofuels and assesses the economical, political and technological factors critical to the diffusion of advanced biofuels. This study comprises economic policies, processes of technological diffusion of emerging technologies and a methodology for modelling possible transportation fuel scenarios. In order to model future scenarios, Stochastic Automata Networks (SAN) are used, a structured formalism that provides a high-level abstraction to represent continuous and discrete-time Markovian models. The results show that in order to boost development of advanced biofuels, public investment in R&D is the most important policy to be adopted. Developing strategies aimed to renewable resources; applying tax incentives and subsidies; and issuing mandatory country objectives are also encouraged.

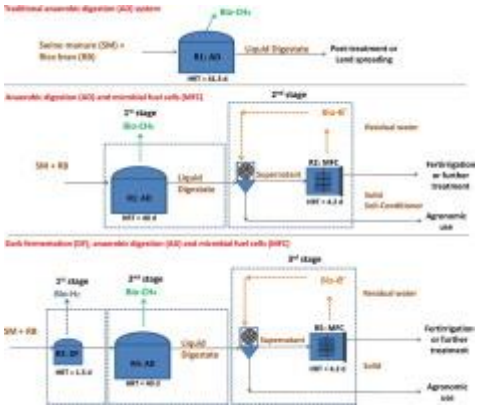
Dark fermentation, anaerobic digestion and microbial fuel cells: An integrated system to valorize swine manure and rice bran

Fecha de Publicación: Octubre 2016

Fuente: Waste Management, Volume 56
Autores: Andrea Schievano, Tommy Pepè Sciarria, Yong Chang Gao, Barbara Scaglia, Silvia Salati, Marina Zanardo, Wei Quiao, Renjie Dong, Fabrizio Adani
Abstract

This work describes how dark fermentation (DF), anaerobic digestion (AD) and microbial fuel cells (MFC) and solid-liquid separation can be integrated to co-produce valuable biochemicals (hydrogen and methane), bioelectricity and biofertilizers. Two integrated systems (System 1: AD+MFC, and System 2: DF+AD+MFC) are described and compared to a traditional one-stage AD system in converting a mixture (COD=124±8.1gO2 kg^{-1} Fresh Matter) of swine manure and rice bran. System 1 gave a biomethane yield of 182 LCH4 kg^{-1} COD-added, while System 2 gave L yields of bio-hydrogen and bio-methane of 27.3±7.2LH2 kg^{-1} COD-added and 154±14LCH4 kg^{-1} COD-added, respectively. A solid-liquid separation (SLS) step was applied to the digested slurry, giving solid and liquid fractions. The liquid fraction was treated via the MFC-steps, showing power densities of 12–13Wm^{-3} (500Ω) and average bioelectricity yields of 39.8Whkg^{-1} COD to 54.2Whkg^{-1} COD.

Graphical abstract



Efficiency and biotechnological aspects of biogas production from microalgal substrates

Fecha de Publicación: 20 Septiembre 2016
Fuente: Journal of Biotechnology, Volume 234
Autores: Viktor Klassen, Olga Blifernez-Klassen, Lutz Wobbe, Andreas Schlüter, Olaf Kruse, Jan H. Mussgnug
Abstract

Photosynthetic organisms like plants and algae can harvest, convert, and store solar energy and thus represent readily available sources for renewable biofuels production on a domestic or industrial scale. Anaerobic digestion (AD) of the

organic biomass yields biogas, containing methane and carbon dioxide as major constituents. Combustion of the biogas or purification of the energy-rich methane fraction can be applied to provide electricity or fuel. AD procedures have been applied for several decades with organic waste, animal products, or higher plants and more recently, utilization of photosynthetic algae as substrates have gained considerable research interest. To provide an overview of recent research efforts made to characterize the AD process of microalgal biomass, we present extended summaries of experimentally determined biochemical methane potentials (BMP), biomass pretreatment options and digestion strategies in this article. We conclude that cultivation options, biomass composition and time of harvesting, application of biomass pretreatment strategies, and parameters of the digestion process are all important factors, which can significantly affect the AD process efficiency. The transition from batch to continuous microalgal biomass digestion trials, accompanied by state-of-the-art analytical techniques, is now in demand to refine the assessments of the overall process feasibility.

Influence of temperature on Chlorella vulgaris growth and mortality rates in a photobioreactor

Fecha de Publicación: Septiembre 2016
Fuente: Algal Research, Volume 18
Autores: Rui Serra-Maia, Olivier Bernard, Ana Gonçalves, Sakina Bensalem, Filipa Lopes
Abstract

The ability of microalgae to fix carbon dioxide and convert it into biofuels, foods and other valuable products has drawn a lot of scientific attention in the last decades. In the last years a number of works aimed at understanding the influence of daily and seasonal temperature fluctuations that affect cell metabolism, and thus biomass production efficiency, have been carried out. However the impact of temperature on cell mortality has never been considered, while temperatures higher than the optimal growth temperature are often reached in summer for outdoor cultivation. This paper explores the effect of high temperatures both on mortality and growth for cultures of Chlorella vulgaris in a photobioreactor. Viability was measured with fluorescein diacetate (FDA), and thus mortality and growth rates were estimated, together with chlorophyll a and intracellular contents in carbon and nitrogen. While the fraction of viable cells decreased at higher temperatures, viable growth and mortality increased from 20°C to 28°C. Chl a :C results suggest that temperature induced photoacclimation in the viable fraction of cells at higher temperatures. A Hinshelwood model was fitted to the data and appropriately described the mortality increase with temperature. Mechanisms affecting growth and mortality rates at high

temperature are then discussed.

Biomass production and nutrient assimilation by a novel microalga, Monoraphidium spp. SDEC-17, cultivated in a high-ammonia wastewater

Fecha de Publicación: 1 Septiembre 2016
Fuente: Energy Conversion and Management, Volume 123
Autores: Liqun Jiang, Haiyan Pei, Wenrong Hu, Qingjie Hou, Fei Han, Changliang Nie

Abstract

To obtain suitable microalgae species for successful algal biomass production from low-cost wastewater, four axenic algae strains were isolated from a local lake. Through acclimation with the high-ammonia complex wastewater (CW) of a gourmet powder factory, one algae species showed good ability to yield biomass and endure high-ammonia conditions (>170mgL^{-1}) in CW. This was verified as a Monoraphidium spp. by molecular identification, and named as SDEC-17. The algae were 27–60μm in length and 4–10μm in width, with relatively low specific surface area for withstanding ammonia ingress through the cell membrane. The final biomass densities of SDEC-17 in CW (1.29±0.09gL^{-1}) and BG11 medium (1.31±0.08gL^{-1}) did not show a statistically significant difference (p>0.05). Moreover, protein content was stimulated to 44% by CW, compared to 35% in BG11. Lipid accumulation of SDEC-17 was not significantly influenced by CW, and fatty acid profiles resembled those of palm oil. The algae would utilize ammonia first under conditions with various nitrogen sources present, and absorb large amounts of phosphorus from the wastewater. Thus, phosphorus and ammonia were removed with efficiencies of nearly 100%, satisfying the discharge standard of pollutants for municipal wastewater treatment plants. These results suggested that Monoraphidium spp. SDEC-17 is a promising candidate for algae biomass production and possibly chemical energy recovery from the complex wastewater.

Effect of microalgae with semicontinuous harvesting on water quality and zootechnical performance of white shrimp reared in the zero water exchange system

Fecha de Publicación: Mayo–Julio 2016
Fuente: Aquacultural Engineering, Volumes 72–73
Autores: Hongxing Ge, Jian Li, Zhiqiang Chang, Ping Chen, Mingming Shen, Fazhen Zhao

Abstract

Microalgae cannot only provide nutrients for aquatic animals but also be useful in wastewater treatment in aquaculture. Up to now, little is known on the potential biological and economic benefits of microalgae application in intensive culture mode of shrimp. To evaluate the effects of 3 marine feed microalgae in Litopenaeus vannamei culture, a 84-day experiment was performed in this study, and water quality, Vibrio counts in water and shrimp, and shrimp growth performance in cement tanks seeded with Platymonas helgolandica (T1), Chlorella vulgaris (T2) and Chaetoceros mulleri (T3) at 0.02mg Chl-a l^{-1}, respectively, were compared with that in tanks without microalgae (Control). At 06:00 DO in all treatment tanks was significantly higher than that in control tanks (p <0.05). Whereas DO at 18:00 in treatment tanks was significantly higher than that in control tanks (p <0.05). The TAN concentration was significantly higher (p <0.05) in the control than that in the treatments. At day 42, day 56, day 70 and day 84, the NO2-N concentration mean values were significantly higher (p <0.05) in the control, followed by T1, T2 and T3. At the end of the experiment, Water pH in the control (7.4) was significantly lower than that in the treatments (8.44, 8.53 and 8.45 respectively) (p <0.05). Significantly lower Vibrio counts were generally observed in the treatment tanks (p <0.05), and the counts of presumptive Vibrio in shrimp stomach and intestines were significantly higher in the control compared to that in the treatments (p <0.05). The highest final average weight (18.04g) was observed in T1, which was significantly higher than that in the control (p <0.05). T1 had the highest shrimp yield (4.41kgm^{-3}) at harvest, and the difference was significant (p <0.05). T1 tended to have the highest average weight gain (1.5g $week^{-1}$) and lowest feed conversion ratio. The shrimp survival was significantly higher in T1, T2 and T3 (81.50%, 79.44% and 77.69%, respectively) than in the control (p <0.05). The present study showed that all three microalgae in no water exchange system had positive effects on water quality and shrimp productive performance. Therefore, all three species are suitable as biofilter in situ in shrimp culture system, suggesting that microalgae have a promising potential for shrimp culture with no water exchange. Further research is needed to demonstrate the harvest and the potential applications of the microalgae.

Use of Spirulina biomass produced from treatment of aquaculture wastewater as agricultural fertilizers

Fecha de Publicación: Abril 2016
Fuente: Algal Research, Volume 15
Autores: Shy Chyi Wuang, Mar Cho Khin, Pei Qiang Danny Chua, Yanpei Darren Luo
Abstract

Microalgal research has been an area of great interest as microalgae have higher productivities than land plants and can be used for the production of valuable commodities such as biofuel, animal feeds and agricultural fertilizers, among others. To enhance the economic feasibility of algal-based commodities, the growth of microalgae can be coupled to wastewater remediation. The technical feasibility of cultivating Spirulina platensis with fish water for production of algae fertilizers was investigated. The remediation potential of S. platensis was found to be good for ammonia and nitrate removal, but inadequate for nitrite removal. Its specific growth rate of 0.026h^{-1} and the nutrient reduction times compare well with various literature reports. This work provides insight into the potential of algal biomass as agricultural fertilizers, when coupled with aquaculture wastewater remediation. The ability of Spirulina-based fertilizers to enhance plant growth was demonstrated in leafy vegetables such as Arugula (Eruca sativa), Bayam Red (Ameranthus gangeticus) and Pak Choy (Brassica rapa ssp. chinensis). The germination of Chinese Cabbage (B. rapa ssp. chinensis) and Kai Lan (Brassica oleracea alboglabra) also improved significantly in terms of seedlings' dry weight.

Bioremediation and biomass harvesting of anaerobic digested cheese whey in microalgal-based systems for lipid production

Fecha de Publicación: Diciembre 2016
Fuente: Ecological Engineering, Volume 97
Autores: B. Riaño, S. Blanco, E. Becares, M.C. García-González
Abstract

Agro-industrial wastewaters are potential resources for production of microalgae biofuels. The aim of the present work was to determine the feasibility of a semi-continuously fed microalgal-based system for the treatment of anaerobic digested cheese whey (AD) and to evaluate biomass productivity and lipid accumulation for a period of 77d. The effect of increasing ammonium loading rate (ALR) and decreasing hydraulic retention time (HRT) was evaluated. Maximum biomass productivity and lipid content were 12.0gm^{-2} d^{-1} and 12.3%, respectively, achieved when operating at an ALR of 12.9mgL^{-1} d^{-1} and at a HRT of 5d. Under these conditions, soluble chemical oxygen demand (SCOD), ammonium and soluble phosphorous (SP) removal accounted for 94%, 92% and 20%, respectively. Additionally, the effectiveness of flocculation induced by increase pH to harvest produced biomass was investigated. Flocculation efficiencies up to 90% were obtained for a pH of 13.5 regardless culture broth characteristics, and therefore, this process can be used as a pre-concentrated step of microalgal-bacterial suspensions.

Microalgal post-treatment of anaerobically digested agro-industrial wastes for nutrient removal and lipids production

Fecha de Publicación: Disponible online 17 Noviembre 2016
Fuente: Bioresource Technology
Autores: Eleni Koutra, George Grammatikopoulos, Michael Kornaros
Abstract

The aim of this study was to investigate the effectiveness of cultivating Parachlorella kessleri and Acutodesmus obliquus, in anaerobic digestion effluent (ADE) derived from the co-digestion of end-of-life dairy products with mixtures of agro-industrial wastes. To this end, their performance under sterile and non-sterile conditions and different ADE loadings was evaluated, in terms of biomass and lipid production, nutrient removal efficiency and vitality of the photosynthetic apparatus. 10% (v/v) ADE loading inhibited growth over 9–12days of cultivation, however biomass yields of 1.1 and 1gL^{-1}, 22.7% and 19.5% (w/w) fatty acids concentration, as well as NH3-N assimilation of 49.7mgL^{-1} and 32.3mgL^{-1} and TP removal of 84.2% and 84% were recorded for P. kessleri and A. obliquus, respectively. Among all the ADE-based treatments tested, P. kessleri outperformed A. obliquus, with no differences observed between sterilized and non-sterilized ADE.

Cultivation of four microalgae species in the effluent of anaerobic digester for biodiesel production

Fecha de Publicación: Disponible online 16 Noviembre 2016
Fuente: Bioresource Technology
Autores: Ga-Yeong Kim, Yeo-Myeong Yun, Hang-Sik Shin, Jong-In Han
Abstract

This study investigated if an effluent from anaerobic digestion (AD) system can be used as a nutrients source for the microalgae cultivation, and in so doing, if the effluent can be properly treated. Nitrogen and phosphorus in the AD effluent well supported microalgal growth, and their removal efficiency reached >97.9% and 99.2%, respectively. Among four different algal species tested, Micractinium inermum particularly stood out, showing the highest biomass and FAME productivity: 0.16gL^{-1} d^{-1} with 3.23gL^{-1} of dry cell weight, and 0.04gL^{-1} d^{-1} with 27.54% (w/w) of FAME contents, respectively. As the concentrations of the nutrients decreased over time, the FAME contents were increased and its quality as well, satisfying several biodiesel quality standards. This study supports that the AD effluent can indeed serve as a cheap and nutrient-rich medium for microalgae cultivation, and equally importantly, microalgae can be a

workable treatment option for it.

Fertilizer assisted optimal cultivation of microalgae using response surface method and genetic algorithm for biofuel feedstock

Fecha de Publicación: 15 Noviembre 2016
Fuente: Energy, Volume 115, Part 1
Autores: Avik Banerjee, Chandan Guria, Subodh K. Maiti
Abstract

Fertilizer based culture medium is formulated for the cultivation of Nannochloropsis sp. by selecting appropriate environmental parameters and nutrients. The influences of light intensity, temperature, NaCl, NaHCO3 and fertilizer are investigated on biomass, lipid and eicosapentaenoic acid productivity. Five-level-five-factor central composite design assisted response surface method is used for optimal cultivation of microalgae and results are compared with the genetic algorithm. A significant improvement in biomass, lipid and eicosapentaenoic acid productivity is obtained from the optimally formulated fertilizer medium using genetic algorithm over response surface method based fertilizer medium and standard culture medium. Using simple genetic algorithm, following optimal parameters, i.e., light intensity (μmol m^{-2} s^{-1}), temperature (°C), NaCl (M), NaHCO3, (g L^{-1}) and fertilizer (g L^{-1}) are obtained for the maximum productivity of biomass (0.77 g L^{-1}), lipid (47.91% of biomass) and eicosapentaenoic acid (26.67% of lipid): (125, 24.28, 0.55, 1.09, 1.07), (118, 21.79, 0.50, 1.13, 1.04) and (87.5, 17, 0.25, 1.09, 1.07), respectively. Two different multi-objective optimization problems are formulated and solved using elitist non-dominated sorting genetic algorithm to find the optimum operating variables resulting characteristic Pareto optimal solutions. Effects of the variables and their interactions on Nannochloropsis sp. cultivation, lipid and eicosapentaenoic acid productivity are successfully revealed.

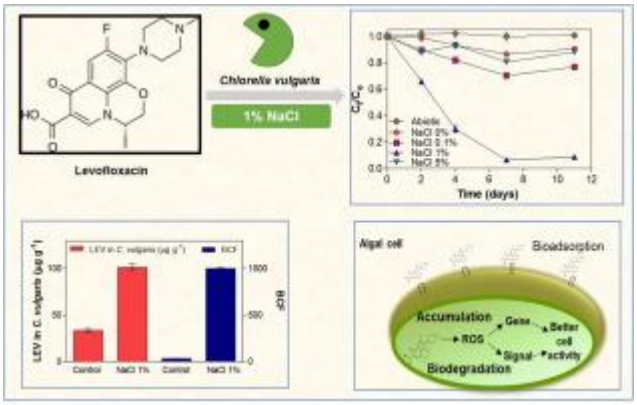
Biodegradation of levofloxacin by an acclimated freshwater microalga, Chlorella vulgaris

Fecha de Publicación: Disponible online 5 Noviembre 2016
Fuente: Chemical Engineering Journal
Autores: Jiu-Qiang Xiong, Mayur B. Kurade, Byong-Hun Jeon
Abstract

The extensive contamination of levofloxacin (LEV) in aquatic ecosystems has attracted increasing attention because of the potential for development of

bacterial resistance and its eco-toxicity to non-target organisms. Biodegradation of LEV was significantly improved upon the acclimation of a freshwater microalga, Chlorella vulgaris and in the presence of elevated salinity. Among the six wild species (Chlamydomonas mexicana, Chlamydomonas pitschmannii, Chlorella vulgaris, Ourococcus multisporus, Micractinium resseri, Tribonema aequale), C. vulgaris showed the highest removal capacity (12%) of LEV at $1mgL^{-1}$. The acclimated C. vulgaris, which was pre-exposed to $200mgL^{-1}$ of LEV for 11days, exhibited enhanced removal of $1mgLEVL^{-1}$ by 16% after 11days of cultivation. The addition of 1% (w/v) sodium chloride into the microalgal media significantly improved LEV removal by >80% in the C. vulgaris culture. The bioaccumulation of LEV at day 11 in C. vulgaris cells without NaCl was $34\mu gg^{-1}$, which was elevated to $101\mu gg^{-1}$ LEV at 1% NaCl. The bioconcentration factor for LEV was 34 and 1004 in 0 and 1% NaCl, respectively. The mass balance analysis of LEV showed that more than 90% of LEV was biodegraded by C. vulgaris at day 11 with the addition of 1% NaCl. These results demonstrated that the enhanced removal of LEV by salinity was mainly through bioaccumulation and subsequent intracellular biodegradation by C. vulgaris cells.

Graphical abstract



Waste Biorefinery: A New Paradigm for a Sustainable Bioelectro Economy

Fecha de Publicación: Noviembre 2016
Fuente: Trends in Biotechnology, Volume 34, Issue 11
Autores: S. Venkata Mohan, Sai Kishore Butti, K. Amulya, Shikha Dahiya, J. Annie Modestra

Abstract

A waste biorefinery is a means to valorize waste as a renewable feedstock to recover biobased materials and energy through sustainable biotechnology. This approach holistically integrates remediation and resource recovery. Here we discuss the various technologies employable to construct a waste biorefinery platform and its place in a biobased economy.

Mixotrophic cultivation of Nephroselmis sp. using industrial wastewater for enhanced microalgal biomass production

Fecha de Publicación: Octubre 2016
Fuente: Ecological Engineering, Volume 95
Autores: Min-Kyu Ji, Hyun-Shik Yun, Buyng Su Hwang, Akhil N. Kabra, Byong-Hun Jeon, Jaeyoung Choi
Abstract

Effect of liquid crystal display (LCD) wastewater on the biomass production and biochemical composition of a green microalga Nephroselmis sp. cultivated in Bold's Basal Medium (BBM) was investigated. Different dilutions (1/250-1/10,000) of LCD wastewater with BBM were tested in the presence of 5% flue gas CO2. Nephroselmis sp. showed the highest growth (0.37gL^{-1}), lipid productivity (14.2mgL^{-1} day^{-1}), carbohydrate productivity (12.5mgL^{-1} day^{-1}), β-carotene+lutein productivity (74.2μgL^{-1} day^{-1}) and nutrient removal (35.0mg TNL^{-1} and 11.6mg TPL^{-1}) with 1/1000 diluted LCD wastewater after 6days of cultivation. Cultivation with LCD wastewater increased the microalgal saturated and monounsaturated fatty acid contents up to 9 and 24%, respectively. Application of LCD wastewater improved the growth, lipid/carbohydrate/carotenoids productivity and nutrient removal efficiency of Nephroselmis sp., which can be a cost effective strategy for microalgal biomass production.

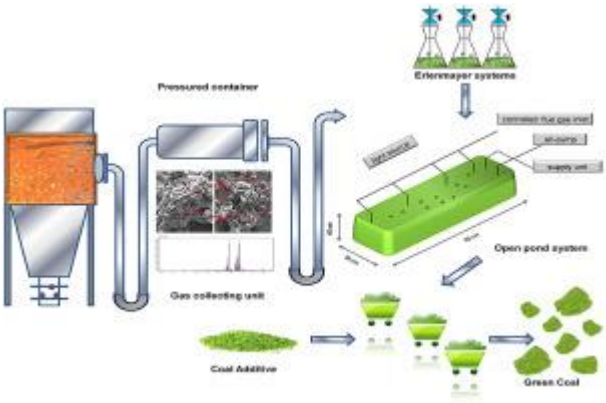
A novel coal additive from microalgae produced from thermal power plant flue gas

Fecha de Publicación: 1 Octubre 2016
Fuente: Journal of Cleaner Production, Volume 133
Autores: Burcu Ertit Taştan, Turgay Tekinay
Abstract

Current techniques for cleaning flue gas produced by coal-fired thermal power plants have high capital and operational costs and are not effective enough. Ongoing research focuses on increasing efficiency of power plants by using coal additives and biological treatment methods especially microalgae for flue gas treatment. Here, we propose use of a resistant microalgae for flue gas treatment and using its biomass as a novel coal additive. Utilization of CO2 from thermal power plant coal samples by bio-stimulated Scenedesmus sp. was investigated for producing a novel coal additive material for use in thermal power plants. Scenedesmus sp. biomass was stimulated by IAA (3-Indoleacetic acid) and VO (Viburnum opulus) promoters. A novel coal additive material with 8.7% lower amounts of ash and 26.17% higher calorific value, termed as "green coal" was

produced in this system. The maximum biomass was produced with lowest culture media consumption, minimum time, highest temperature and highest flow rate. The XRF analyses were performed, fatty acid methyl ester levels were determined and morphology of Scenedesmus sp. were observed. The growth of Scenedesmus sp. in open pond system by bubbling with 9.6 vvm of flue gas resulted in volumetric biomass productivity (P max) of 0.033 g/L/d and CO2 fixation rate of 1512.22 mg CO2/day. This system has the potential to replace other conventional coal additive and cleaning methods since it needs lower energy expenditure and lower use of chemicals.

Graphical abstract



Two-scale model for quantifying the effects of laminar and turbulent mixing on algal growth in loop photobioreactors

Fecha de Publicación: 1 Enero 2017
Fuente: Applied Energy, Volume 185, Part 2
Autores: Shoaib Shariff, Saikat Chakraborty
Abstract

This paper quantifies the mixing effects on algal growth in loop photobioreactors using two-scale low-dimensional models derived through spatial averaging of the Convection–Diffusion–Reaction equation using Liapunov–Schmidt technique of the classical bifurcation theory. The local mixing in the reactor is captured in terms of the mixing time and the difference between the mixing-cup and the spatially averaged concentrations of the algae, which are representatives of the convection scale in the fluid phase and the reaction scale at the algal surface, respectively. We solve coupled unsteady-state low-dimensional partial differential equations (PDEs) to simulate the temporal dynamics of the algae (Chlorella vulgaris), carbon dioxide and oxygen along the reactor in laminar and turbulent mixing regimes. Analytical solutions are derived for the unsteady and pseudo-steady state cases in the turbulent regime. We show that while laminar mixing results in significant scale separation between the convection and

reaction scales, turbulent mixing – propelled by the turbulent diffusivity – eliminates all scale separation and mass transfer limitations in the photobioreactor and maximizes algal growth. Increasing Reynolds number (Re) increases the dimensionless mixing time (and thus, the scale separation) in the laminar regime but has negligible effect on turbulent mixing. Thus, the system transitions from the mixing-limited asymptote in the laminar regime to the reaction-limited asymptote in the turbulent regime. For maximum algal growth per unit energy cost, we recommend operating loop photobioreactors at a low Re (>2300) in the turbulent flow regime so as to generate turbulent mixing for rapid mass transfer of the growth substrates and the algae between the convection (fluid) and the reaction (solid) phases, at optimal pressure drops. Our two-scale model would be an important design tool for quantifying mixing effects while scaling up photobioreactors.

Removal of Cr(VI) using a cyanobacterial consortium and assessment of biofuel production

Fecha de Publicación: Disponible online 17 Noviembre 2016
Fuente: International Biodeterioration & Biodegradation
Autores: Sushovan Sen, Susmita Dutta, Sohini Guhathakurata, Jitamanyu Chakrabarty, Somnath Nandi, Abhishek Dutta
Abstract

The use of cyanobacteria for the removal of heavy metals from wastewater is gaining interest due to its lower cost of operation and being environmentally benign. As chromium (Cr(VI)) is potentially toxic and carcinogenic for humans, its removal from water and wastewater is obligatory in order to avoid water pollution. In the present study, the capacity of a living cyanobacterial consortium consisting of Limnococcus limneticus and Leptolyngbya subtilis, collected from East Kolkata Wetland, a wetland of international importance, for removal of Cr(VI) is investigated at different operating conditions. Input variables such as initial concentration of Cr(VI), pH and inoculum size are varied using one factor at a time (OFAT) analysis in the range of 5–30 mg/L, 7–11 and 2–10%, respectively. An optimum removal of 50% is achieved after 12 days of inoculation with initial concentration of 15 mg/L Cr(VI) at pH 9 and with inoculum size 10%. Scanning Electron Microscopy (SEM) and Energy Dispersive Spectroscopy (EDS) studies have ascertained the uptake of Cr(VI) by the living consortium. Fourier Transform Infrared Spectroscopy (FTIR) study has revealed that the amine, phosphate and carbonyl groups are involved for binding vis-à-vis biosorption of Cr(VI). The increase in inoculum size improves the percentage removal of Cr(VI). To assess the possibility of biofuel production, the cells are harvested for their dry biomass and lipid content. An increase in both dry biomass and lipid content is observed when living consortium is grown in Cr(VI) contaminated simulated wastewater instead of BG-11 medium. A regression

model is developed to predict the interactive effect of four input variables namely initial concentration of Cr(VI), initial solution pH, inoculum size and time with three output variables namely dry biomass, lipid content and percentage removal of Cr(VI). Finally, Response Surface Methodology (RSM) is employed to optimize the process conditions for removal of Cr(VI). The optimum condition obtained from RSM study is initial Cr(VI) concentration:10 mg/L, pH: 9, inoculum size: 4%, time: 9 days and the predicted percentage removal (51%) matches quite well with experimental one (52.7%).

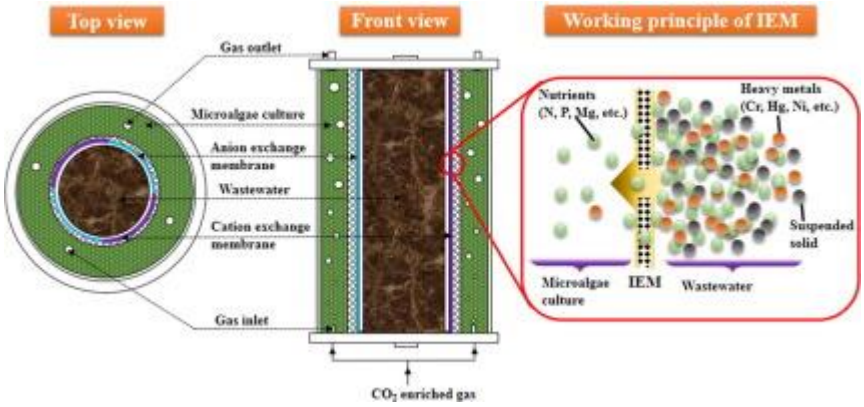
An annular photobioreactor with ion-exchange-membrane for non-touch microalgae cultivation with wastewater

Fecha de Publicación: Noviembre 2016
Fuente: Bioresource Technology, Volume 219
Autores: Hai-Xing Chang, Qian Fu, Yun Huang, Ao Xia, Qiang Liao, Xun Zhu, Ya-Ping Zheng, Chi-He Sun

Abstract

To eliminate the negative impacts of pollutants in wastewater (such as suspended solids, excess N, P, heavy metals) on microalgae growth, an annular ion-exchange-membrane photobioreactor (IEM-PBR) was proposed in this study. The IEM-PBR could avoid direct mixing of algae cells with wastewater by separating them into two chambers. In the IEM-PBR, the nutrients (mainly N and P) in wastewater continuously permeated into microalgae cultures through the ion-exchange-membrane for microalgae growth, while the pollutants hardly permeated into microalgae cultures. Three types of representative wastewater were investigated to evaluate the performance of the IEM-PBR. When cultivated with wastewater containing excess nutrients, high turbidity and excess heavy metals, microalgae biomass concentrations were significantly improved from 2.34, 2.15 and 0gL^{-1} in the traditional PBR to 4.24, 3.13 and 2.04gL^{-1} in the IEM-PBR. Correspondingly, the removal efficiencies of N and P in wastewater were also greatly improved by using the IEM-PBR.

Graphical abstract



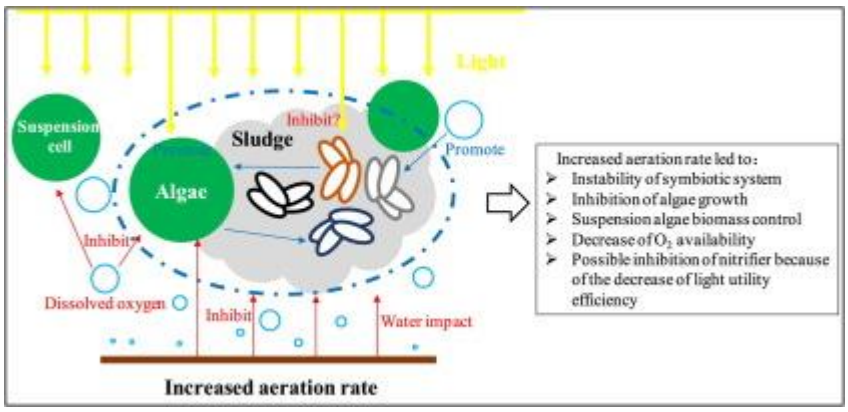
Effect of aeration rate on performance and stability of algal-bacterial symbiosis system to treat domestic wastewater in sequencing batch reactors

Fecha de Publicación: Diciembre 2016
Fuente: Bioresource Technology, Volume 222
Autores: Cong-Cong Tang, Wei Zuo, Yu Tian, Ni Sun, Zhen-Wei Wang, Jun Zhang

Abstract

This study investigated aeration rate (0, 0.2, 0.4 and 1.0L/min) effects on algal-bacterial symbiosis (ABS) and conventional activated sludge (CAS) systems while treating domestic wastewater in sequencing batch reactors. Experiment results showed that ABS system performed better on $NH4^{+}$-N, total nitrogen and total phosphorus removal than CAS system, especially under lower aeration rate condition (0.2Lair/min), with removal efficiencies improvements of 18.90%, 12.45% and 46.66%, respectively. The mechanism study demonstrated that a favorable aeration rate reduction (half of traditional value in CAS system) could enhance algae growth but weaken hydraulic shear force, which contributed to the interactions between algae and sludge flocs and further stability of ABS system. In addition, algae growth protected both ammonia and nitrite oxidizing bacteria from optical damage. It is expected that the present study would provide some new insights into ABS system and be helpful for development of low-energy demand wastewater treatment process.

Graphical abstract



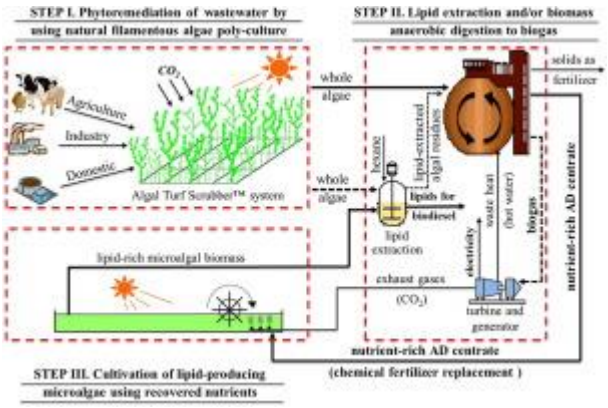
Phytoremediation of agriculture runoff by filamentous algae poly-culture for biomethane production, and nutrient recovery for secondary cultivation of lipid generating microalgae

Fecha de Publicación: Diciembre 2016
Fuente: Bioresource Technology, Volume 222
Autores: Pavlo Bohutskyi, Steven Chow, Ben Ketter, Coral Fung Shek, Dean Yacar, Yuting Tang, Mark Zivojnovich, Michael J. Betenbaugh, Edward J. Bouwer

Abstract

An integrated system was implemented for water phytoremediation and biofuel production through sequential cultivation of filamentous algae followed by cultivation of lipid-producing microalgae Chlorella sorokiniana. Natural poly-culture of filamentous algae was grown in agricultural stormwater using the Algal Turf Scrubber®, harvested and subjected for lipid extraction and/or methane production using anaerobic digestion (AD). While filamentous algae lipid content was too low for feasible biodiesel production (<2%), both whole biomass and lipid-extracted algal residues (LEA) yielded ~0.2LmethanepergVS at loading rates up to 5gVS/L-day. Importantly, essential macro-nutrients and trace elements captured from stormwater were released into the AD effluent as soluble nutrients and were successfully tested as fertilizer replacement for cultivation of lipid-accumulating C. sorokiniana in a subsequent stage. Accordingly, filamentous algae poly-culture was exploited for waste nutrient capturing and biofuel feedstock generation. These nutrients were recovered and reused as a concentrated supplement for potentially high-value microalgae.

Graphical abstract



Biodiesel production potential of wastewater treatment high rate algal pond biomass

Fecha de Publicación: Diciembre 2016
Fuente: Bioresource Technology, Volume 221
Autores: Abbas Mehrabadi, Rupert Craggs, Mohammed M. Farid
Abstract

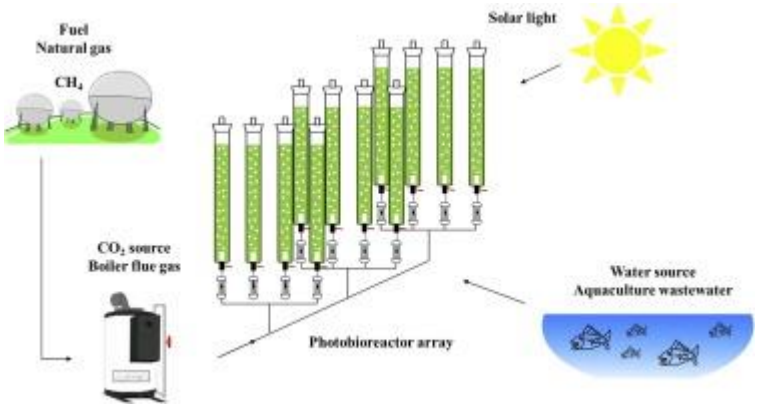
This study investigates the year-round production potential and quality of biodiesel from wastewater treatment high rate algal pond (WWT HRAP) biomass and how it is affected by CO2 addition to the culture. The mean monthly pond biomass and lipid productivities varied between 2.0±0.3 and 11.1±2.5gVSS/m^2/d, and between 0.5±0.1 and 2.6±1.1g/m^2/d, respectively. The biomass fatty acid methyl esters were highly complex which led to produce low-quality biodiesel so that it cannot be used directly as a transportation fuel. Overall, 0.9±0.1g/m^2/d (3.2±0.5ton/ha/year) low-quality biodiesel could be produced from WWT HRAP biomass which could be further increased to 1.1±0.1g/m^2/d (4.0ton/ha/year) by lowering culture pH to 6–7 during warm summer months. CO2 addition, had little effect on both the biomass lipid content and profile and consequently did not change the quality of biodiesel.

Simultaneous microalgal biomass production and CO2 fixation by cultivating Chlorella sp. GD with aquaculture wastewater and boiler flue gas

Fecha de Publicación: Diciembre 2016
Fuente: Bioresource Technology, Volume 221
Autores: Chiu-Mei Kuo, Jhong-Fu Jian, Tsung-Hsien Lin, Yu-Bin Chang, Xin-Hua Wan, Jinn-Tsyy Lai, Jo-Shu Chang, Chih-Sheng Lin
Abstract

A microalgal strain, Chlorella sp. GD, cultivated in aquaculture wastewater (AW) aerated with boiler flue gas, was investigated. When AW from a grouper fish farm was supplemented with additional nutrients, the microalgal biomass productivity after 7days of culture was 0.794gL^{-1} d^{-1}. CO2 fixation efficiencies of the microalgal strains aerated with 0.05, 0.1, 0.2, and 0.3vvm of boiler flue gas (containing approximately 8% CO2) were 53, 51, 38, and 30%, respectively. When the microalgal strain was cultured with boiler flue gas in nutrient-added AW, biomass productivity increased to 0.892gL^{-1} d^{-1}. In semi-continuous cultures, average biomass productivities of the microalgal strain in 2-day, 3-day, and 4-day replacement cultures were 1.296, 0.985, and 0.944gL^{-1} d^{-1}, respectively. These results demonstrate the potential of using Chlorella sp. GD cultivations in AW aerated with boiler flue gas for reusing water resources, reducing CO2 emission, and producing microalgal biomass.

Graphical abstract



Biochemical compositions and fatty acid profiles in four species of microalgae cultivated on household sewage and agro-industrial residues

Fecha de Publicación: Diciembre 2016
Fuente: Bioresource Technology, Volume 221
Autores: Clediana Dantas Calixto, Jordana Kaline da Silva Santana, Evandro Bernardo de Lira, Patrícia Giulianna Petraglia Sassi, Raul Rosenhaim, Cristiane Francisca da Costa Sassi, Marta Maria da Conceição, Roberto Sassi
Abstract

The potential of four regional microalgae species was evaluated in relation to their cell growth and biomass production when cultured in the following alternative media: bio-composts of fruit/horticultural wastes (HB), sugarcane waste and vinasse (VB) chicken excrements (BCE), raw chicken manure (RCM), and municipal domestic sewage (MDS). The cultures were maintained under controlled conditions and their growth responses, productivities, biochemical compositions, and the ester profiles of their biomasses were compared to the

results obtained in the synthetic media. The MDS and HB media demonstrated promising results for cultivation, especially of Chlorella sp., Chlamydomonas sp., and Lagerheimia longiseta, which demonstrated productivities superior to those seen when grown on the control media. The highest lipid levels were obtained with the HB medium. The data obtained demonstrated the viability of cultivating microalgae and producing biomass in alternative media prepared from MDS and HB effluents to produce biodiesel.

Effects of different culture conditions on the phycoremediation efficiency of domestic wastewater

Fecha de Publicación: Diciembre 2016
Fuente: Journal of Environmental Chemical Engineering, Volume 4, Issue 4, Part A
Autores: Paran Gani, Norshuhaila Mohamed Sunar, Hazel Matias-Peralta, Siti Suhana Jamaian, Ab Aziz Abdul Latiff
Abstract

In this study, Botryococcus sp. was used to bio-remediate domestic wastewater for nutrient removal coupled with biomass production. The experiment was set up to investigate the effect of indoor and outdoor culture conditions on the efficiency of phycoremediation and potential biomass productivity, as influenced by different concentrations. The results showed that the concentration of 10^6 cell/mL successfully removes TP and TOC under an indoor condition at the highest efficiency of 95.4% and 85%, respectively. In addition, there was complete removal (100%) of TN in the domestic wastewater under outdoor conditions. Furthermore, most of the pseudo-first-order kinetic model for the removal of TP, TN, and TOC showed a decreasing pattern proportionate to the increase in phycoremediation time. The highest biomass productivity was also obtained at the same concentration (10^6 cell/mL) for the outdoor (2.6×10^5 cell/mL/d) and indoor (2.4×10^5 cell/mL/d) culture conditions. The outdoor condition provided the highest (p <0.05) biomass productivity. The results of this study suggest that microalgae biomass production combined with domestic wastewater phycoremediation is a sustainable method.

Graphical abstract

Dynamic modelling of microalgae cultivation process in high rate algal wastewater pond

Fecha de Publicación: Disponible online 4 Noviembre 2016
Fuente: Algal Research
Autores: Muhammadu Bello, Panneerselvam Ranganathan, Feargal Brennan
Abstract

In this work, a comprehensive dynamic mathematical modelling to simulate the production of microalgae in a high rate algal pond (HRAP) is attempted. A synergetic algal–bacterial system comprising various interrelated biological and chemical system processes is presented. The dynamic behaviour of HRAP system is studied by solving mass balance equations of different components which account light intensity and gas–liquid mass transfer. The model predictions are compared with the previously reported studies in the literature. The influence of kinetic and operating parameters, including the supply of CO2, the maximum growth rate, pond depth and dilution rates, on the pond performance are evaluated. The sensitivity analysis of important process parameters is also discussed in this study. The developed model, as a tool, can be used to assess the factors that affect the pond performance criteria, including algal productivity and the dynamics of nutrient requirements.

Effects of inoculum size, light intensity, and dose of anaerobic digestion centrate on growth and productivity of Chlorella and Scenedesmus microalgae and their poly-culture in primary and secondary wastewater

Fecha de Publicación: Noviembre 2016
Fuente: Algal Research, Volume 19

Autores: Pavlo Bohutskyi, Debora Cynamon Kligerman, Natalie Byers, Laila Khaled Nasr, Celine Cua, Steven Chow, Chunyang Su, Yuting Tang, Michael J. Betenbaugh, Edward J. Bouwer

Abstract

Scale-up of microalgal biofuel technology is challenged by availability of nitrogen and phosphorus fertilizers and the potential negative impact vast increases in chemical fertilizer demand would have on conventional agriculture. The current study investigated replacement of chemical fertilizers with nutrients sourced from primary and secondary wastewater effluents and anaerobic digestion centrate (ADC). Although primary wastewater effluent possessed a high optical density (OD) and bacterial contamination, it was a superior growth medium for microalgal cultivation than nutrient-scarce secondary effluent. Chlorella sorokiniana and Scenedesmus acutus f. alternans showed higher growth rates, productivities, and robustness than other species or poly-cultures of five species. While supplementing with 5–10% nutrient-rich ADC increased wastewater OD, it also enhanced microalgal growth rates from 0.2–0.3d^{-1} to 0.7–0.9d^{-1} and biomass productivity from 10 to 20mgL^{-1} d to 40–60mgL^{-1} d with greater improvements for secondary effluents. Supplementation with ADC also increased nutrient concentrations (N, P, Mn, B, Zn, Co by >100% and S, Mg, Ca, Mo by 20–60%) and improved the nitrogen to phosphorus (N:P) ratio. Higher ADC dose of 20% inhibited microalgae growth potentially due to ammonia toxicity. Elevation of inoculum doses and light intensity increased final biomass density and productivity, with intensities <140µmol$photonm^{-2}$ s^{-1} limiting algal growth rates. Inoculum doses of ≥2.5×10^5 $cellmL^{-1}$ were most favorable for cultivation of all tested microalgae and for FAME content and composition for a newly characterized strain of Chlorella sorokiniana. Overall, ADC represents an economical fertilizer substitute providing various nutrients needed for microalgal growth and enhancing biofuel sustainability.

Graphical abstract

Parboiled rice effluent: A wastewater niche for microalgae and cyanobacteria with growth coupled to comprehensive remediation and phosphorus biofertilization

Fecha de Publicación: Noviembre 2016
Fuente: Algal Research, Volume 19
Autores: Chandan Mukherjee, Rajojit Chowdhury, Tapan Sutradhar, Momtaj Begam, Sejuti Magdalene Ghosh, Sandip Kumar Basak, Krishna Ray

Abstract

The potential of microalgae and cyanobacteria for bioremediation of wastewater by nutrient uptake combined with simultaneous biomass production is a well recognized perception of today's world. The present study illustrates the treatment of a highly polluted wastewater generated during parboiling of paddy in rice mill industries, widely operational in developing countries where rice is the staple food crop, with the help of microalgal and cyanobacterial isolates capable of growing at high rates in parboiled rice mill effluent (RME). This endeavor leads to comprehensive bioremediation of the said effluent and subsequent use of the harvested biomass as slow release phosphorus biofertilizers and the treated effluent for crop irrigation. The RME-acclimatized algal consortium demonstrated highest growth in terms of fresh weight and greatest remediation efficiency at the end of 36days' treatment of RME, with 93.9% phosphorus and 100% ammonia-nitrogen removal, 98.7%, 91.6% and 93.5% reduction in biological oxygen demand, chemical oxygen demand and total dissolved solid, respectively, and an increment of 186±0.3mgL^{-1} dissolved oxygen, bringing down the pollutants level well below the discharge limits suggested by Central Pollution Control Board, India. Additionally, microalgae in the consortium aggregated in clumps spontaneously in presence of the filaments of Phormidium sp. facilitating easy harvest. The RME-acclimatized algal consortium demonstrated highest accumulation of polyphosphate (poly-P) (0.76±0.01% of dry weight) as well as highest release of phosphorus in non-sterile soil emphasizing the essential role of soil phosphorus solubilizing organisms to leach soluble phosphorus from the insoluble poly-P present in the biomass. The rice seedlings watered with treated RME also showed improved growth effect on shoot height and leaf width. The study results establish the suitability of RME as an excellent growth media for microalgae and cyanobacteria.

PATENTES

Method for treating high ammonia-nitrogen wastewater through nutrition

Page bookmark CN105712490 (A) - Method for treating high ammonia-nitrogen wastewater through nutrition conversion of mixotroph

Inventor(s): ZHOU WENGUANG; RUAN RONGSHENG; WANG JINGHAN; LI JUN + (ZHOU WENGUANG, ; RUAN RONGSHENG, ; WANG JINGHAN, ; LI JUN)

Applicant(s): UNIV NANCHANG + (NANCHANG UNIVERSITY)

Abstract of CN105712490 (A)

The invention discloses a method for treating high ammonia-nitrogen wastewater through nutrition conversion of mixotroph. The method for treating the high ammonia-nitrogen wastewater through nutrition conversion of the mixotroph comprises the following steps: 1, conducting transferring and culture on the mixotroph; 2, conducting high density culture in a culture medium rich in organic carbon or wastewater rich in organic carbon; 3, harvesting heterotrophic cells of the mixotroph; 4, transferring the heterotrophic cells into the high ammonia-nitrogen wastewater for autotrophic culture, absorbing high-concentration nitrogen and ammonia, and purifying the wastewater. According to the method, the method for changing the nutrition metabolism pathway of the mixotroph is introduced for treating the high ammonia-nitrogen wastewater, the treated wastewater can be recycled, the requirement of industrialized wastewater treatment conducted through microalgae is met, and the method is a new approach for conducting sewage treatment through produced microalgae economically and efficiently. The harvested microalgae cells can be further treated and used for preparing biological energy source, animal feed and the like.

Method for culturing high-density oil microalgae to treat yeast industrial wastewater

Page bookmark: CN102718325 (A) - Method for culturing high-density oil microalgae to treat yeast industrial wastewater

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Abstract of CN102718325 (A)

The invention discloses a method for culturing high-density oil microalgae to treat yeast industrial wastewater. The method comprises the following steps of: carrying out clean pre-treatment on wastewater obtained by producing yeast; then adding reducing sugar and nutritive salts to prepare a culture medium; sterilizing, inoculating and fermenting; and discontinuously feeding materials, and carrying out heterotrophism culture, so as to obtain energy microalgae with the cell density of 41.26-50.83g/L and the oil content of 40.86-45.26%.; According to the method disclosed by the invention, a novel efficient and

economical way which combines recycled utilization and energy-form production of industrial organic wastewater discharged in a yeast industrial production process is realized, so that the damages of the organic wastewater to the environment is reduced, and good economic benefits and social benefits are obtained.

Organic sludge-energy recycling method

Page bookmark	US4342650 (A) - Organic sludge-energy recycling method
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Application number:	US19800203723 19801103
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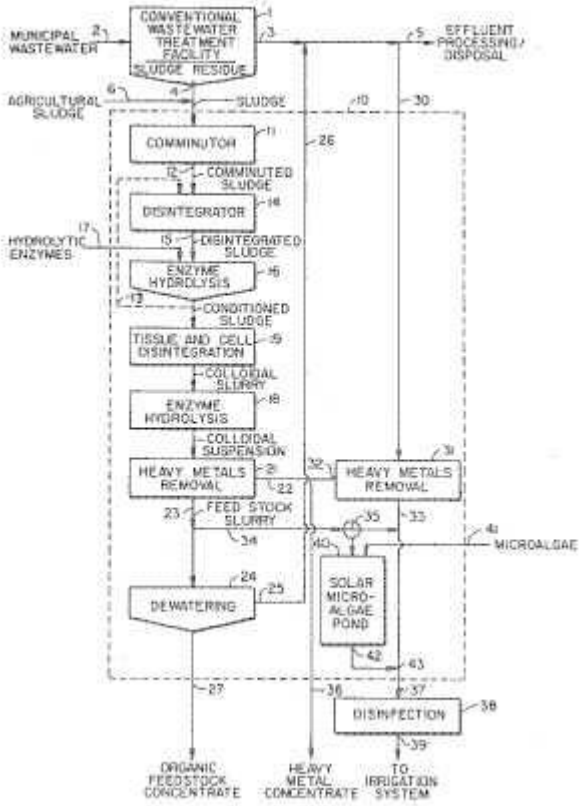
Abstract of US4342650 (A)
A method is described for converting substantially untreated organic sludge into useful substances. The sludge may include primary sludge, a mixture of primary and secondary sludges from municipal wastewater treatment facilities, slurries of agricultural manure, and other organic wastes. The sludge is mechanically comminuted to reduce the size of organic solids, the sludge is then further mechanically disintegrated and thereafter it is subjected to enzyme hydrolysis to produce a biologically stable colloidal slurry with improved biochemical potential reactivity. Typically, the hydrolysis step is followed by a further cell/particle disintegration step and a secondary hydrolysis step. If necessary, heavy metals are removed from the suspension in a chelating step which are recovered as a recyclable concentrate. The suspension can be used as a liquid fertilizer or it can be dewatered. If used as a liquid fertilizer the suspension can be inoculated with microalgae to enrich the fertilizer with nitrogen. Alternatively, the demineralized product may be incinerated or used as a feedstock for other industrial processing.


MUNICIPAL WASTEWATER
CONVENTIONAL WASTEWATER TREATMENT FACILITY
SLUDGE RESIDUE
EFFLUENT PROCESSING/ DISPOSAL
AGRICULTURAL SLUDGE
SLUDGE
COMMINUTOR
COMMINUTED SLUDGE
DISINTEGRATOR
HYDROLYTIC ENZYMES
DISINTEGRATED SLUDGE
ENZYME HYDROLYSIS
CONDITIONED SLUDGE
TISSUE AND CELL DISINTEGRATION
COLLOIDAL SLURRY
ENZYME HYDROLYSIS
COLLOIDAL SUSPENSION
HEAVY METALS REMOVAL
HEAVY METALS REMOVAL
FEED STOCK SLURRY
MICROALGAE
SOLAR MICRO-ALGAE POND
DEWATERING
DISINFECTION
ORGANIC FEEDSTOCK CONCENTRATE
HEAVY METAL CONCENTRATE
TO IRRIGATION SYSTEM

Noticias de interés general:

Global Microalgae DHA Oil Market 2016: Regional Outlook, Analysis, Size, Share, Forecast – 2021.
http://www.medgadget.com/2016/12/global-microalgae-dha-oil-market-2016-regional-outlook-analysis-size-share-forecast-2021.html

Molecular Velcro boosts microalgae's potential in biofuel, industrial applications.
http://www.nanowerk.com/news2/biotech/newsid=45456.php

ABO Members Awarded DOE Funds to Develop Biorefineries
http://algaebiomass.org/blog/9873/abo-members-awarded-doe-funds-develop-biorefineries/

Eventos y Cursos

IV Congreso Internacional de Ambiente y Energías Renovables.
Villa María, Córdoba, Argentina.
14 al 16 de Junio de 2017.

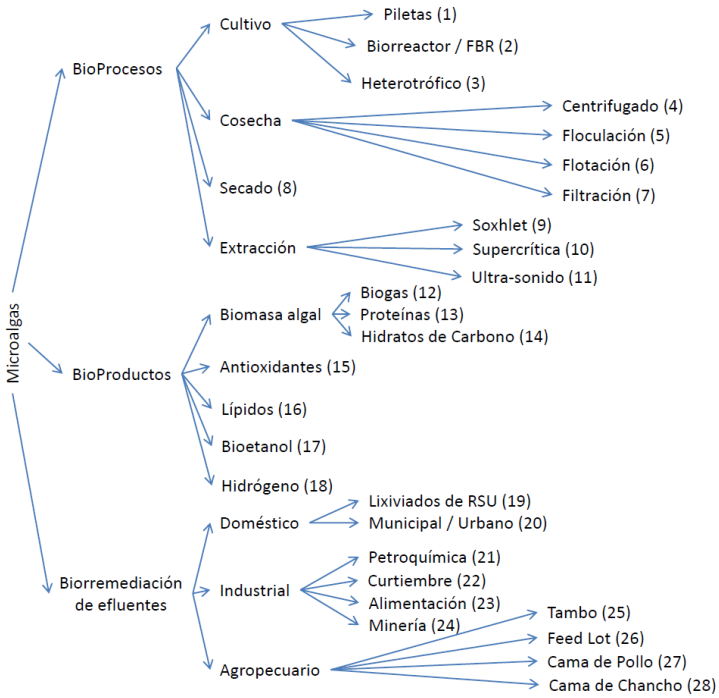
X CONGRESO DE MICRO Y MACROALGAS
Coquimbo, Chile.
19 al 21 de julio de 2017

2017 Algae Biomass Summit
Salt Lake City, Utah, EEUU.
October 29 - November 1, 2017

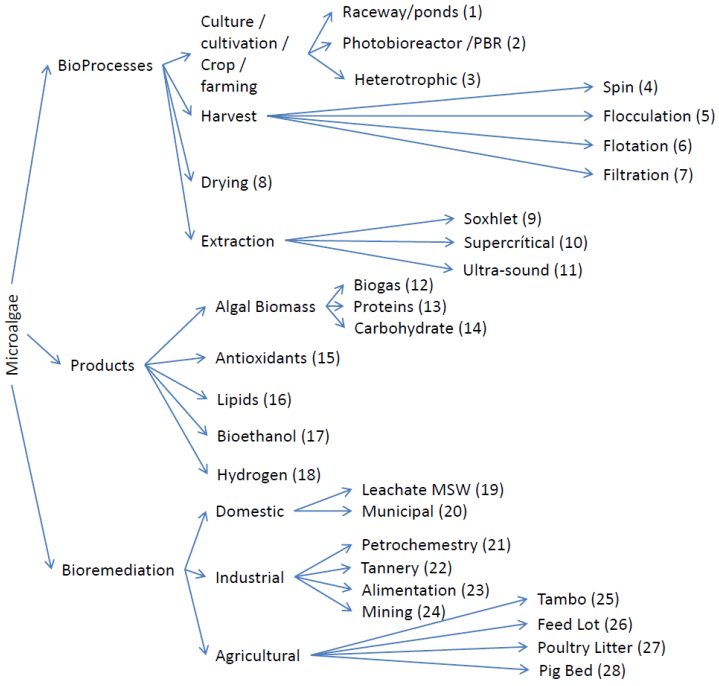
XI CONGRESO DE FICOLOGÍA DE LATINOAMÉRICA Y EL CARIBE y IX REUNIÓN IBEROAMERICANA DE FICOLOGÍA
Santiago de Cali, Colombia.
5 al 10 de noviembre de 2017.

Árbol de categorías

Español



Inglés



TITULO

SUBTITULO