UNIDAD DE VIGILANCIA TECNOLÓGICA E INTELIGENCIA COMPETITIVA

Microalgas

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Contenido

En este boletín se presentan las publicaciones, patentes y noticias de interés del primer trimestre del año 2019 pertenecientes a la rama Bioprocesos del árbol de categorías.

PUBLICACIONES

Microalgae harvesting with the novel flocculant hairy cationic nanocrystalline cellulose.

Fecha: 12 Marzo, 2019
Fuente: Colloids Surf B Biointerfaces. 178:329-336
Autores: Lopez-Exposito P, Campano C, van de Ven TGM, Negro C, Blanco A

Abstract

This paper investigates the flocculation of Chlorella sorokiniana suspensions with a novel cellulose derivative, namely hairy cationic nanocrystalline cellulose (CNCC). CNCC are a brand new family of nanocellulose characterized by having two positively charged amorphous ends joint through a common crystalline shaft. Flocculation was monitored through laser reflectance and its mechanism was studied by means of zeta potential, fractal dimension and turbidity removal. CNCC dosage and shear rate were varied and their effect on floc morphology and filterability were assessed. CNCC effectively flocculated the cultures at dosages well below and over the isoelectric point, being the flocculation mechanisms and floc strength highly dependent on the doses applied. The filtration propensity of flocculated suspensions proved highly sensitive to small differences in flocs' geometry. The aggregation process entailed two phases, a first one in which the CNCC adsorbed on the surface of microalgal cells according to a flat random deposition up to reaching a maximal cell coverage, and a second one in which the free spots left were progressively covered with orthogonally deposited CNCC, being this later configuration the main responsible for intercellular attachment. The present work demonstrates that CNCC is an effective flocculant of microalgal cell suspensions and constitutes an alternative worth exploring for the aggregation of other cells' suspensions.

Influence of growth phase on the harvesting of Scenedesmus acuminatus using ultrafiltration.

Fecha: 10 Abril 2019
Fuente: Sci Total Environ. 660:25-31
Autores: Ye J, Sha J, Liu Q, Zhang X, Hu Q, Chen Y

Abstract

Cellular characteristics and algogenic organic matter (AOM) properties change with culture time. This study aims to understand the changes throughout the growth phase, and their effect on Scenedesmus acuminatus harvesting using ultrafiltration. The variations in cellular particle size distribution, cellular EPS content, and the biochemical composition and molecular weight of AOM were analyzed, followed by the membrane harvesting of the original S. acuminatus suspension, AOM-free cells and cell-free AOM. The results showed that the average flux for the original suspension increased with growth phase and reached an increase of 36.3% in the declining phase. AOM played a greater role than S. acuminatus cells in flux decline for all growth phases. Exponential-phase AOM contained a greater high-MW fraction and more carbohydrates, and the exponential cells were smaller cells and had a higher EPS content; these characteristics resulted in a reduced average flux.

Techno-Functional Properties of Crude Extracts from the Green Microalga Tetraselmis suecica.

Fecha: 25 Julio 2018
Fuente: J Agric Food Chem. 66(29):7831-7838
Autores: Garcia ES, van Leeuwen JJA, Safi C, Sijtsma L, van den Broek LAM, Eppink MHM, Wijffels RH, van den Berg C

Abstract

A mild fractionation process to extract functional biomolecules from green microalgae was implemented. The process includes bead milling, centrifugation, and filtration with several membrane cut-offs. For each fraction, the corresponding composition was measured, and the surface activity and gelation behavior were determined. A maximum protein yield of 12% was obtained in the supernatant after bead milling and between 3.2 and 11.7% after filtration. Compared to whey protein isolate, most of the algae fractions exhibited comparable or enhanced functionality. Surface activity for air-water and oil-water interfaces and gelation activities were notably superior for the retentate fractions compared to the permeates. It is proposed that such functionality in the retentates is due to the presence of hydrophobic compounds and molecular complexes exhibiting a similar behavior as Pickering particles. We demonstrated that excellent functionality can be obtained with crude fractions, requiring minimum processing and, thus, constituting an interesting option for commercial applications.

Edible fungi-assisted harvesting system for efficient microalgae bio-flocculation.

Fecha: Junio 2019
Fuente: Bioresour Technol. 282:325-330
Autores: Luo S, Wu X, Jiang H, Yu M, Liu Y, Min A, Li W, Ruan R

Abstract

Conventional flocculants, commonly used to improve harvesting efficiency, can contaminate the broth and cause microalgae not suitable for food or feed production. In the present study, Pleurotus ostreatus, an edible fungal strain, was developed to improve the harvesting efficiency of microalgae. The results show that Pleurotus ostreatus pellets cultured under 100 rpm agitation resulted in higher harvesting efficiency than pellets cultured under 0 rpm and 150 rpm agitation. Lower pH of the Chlorella sp. suspension resulted in higher harvesting efficiency. The maximum recovery efficiency reached 64.86% in 150 mins. The above process could be used to achieve low cost, flocculant-free harvesting of microalgae as feedstock for feed or food production.

Preparation and characterization of a substitute for Ruditapes philippinarum conglutination mud as a natural bioflocculant.

Fecha: Junio 2019
Fuente: Bioresour Technol. 281:480-484
Autores: Mu J, Wang D, Yang G, Cui X, Yang Q

Abstract

In this study a preparation strategy was attempted to produce a substitute (BBF) for the Ruditapes philippinarum conglutination mud (RPM), which was newly discovered to be a promising natural bioflocculant resource. A stable yield of 73.77 ± 1.79 g L-1 BBF was established by a sequential batch fermentation under optimized conditions via single factor experiments. BBF attained similar flocculation performance as RPM, showing a maximum flocculation rate of 87.92 ± 0.65%. BBF had significant decolorization efficiency on methylene blue, crystal violet and malachite green by 98.78 ± 0.46%, 89.37 ± 0.35% and 99.11 ± 0.17%, respectively. BBF could harvest microalgae Chlorella salina by 84.38 ± 0.57%. High throughput sequencing revealed that Vibrio and Bacillus might be the extracellular polysaccharides producers. The successful preparation will enable a potential industrial production of BBF thus avoid scattered collection of RPM.

Flocculation-flotation harvesting mechanism of Dunaliella salina: From nanoscale interpretation to industrial optimization.

Fecha: 15 Mayo 2019
Fuente: Water Res. 155:352-361
Autores: Besson A, Formosa-Dague C, Guiraud P

Abstract

Dunaliella salina is a green microalgae species industrially exploited for its capacity to produce important amounts of carotenoid pigments. However in low nitrogen conditions in which they produce these pigments, their concentration is low, which results in harvesting difficulties and high costs. In this work, we propose a new solution to efficiently harvest D. salina at the pre-industrial scale, using flocculation/flotation harvesting induced by NaOH addition in the medium. We first show, using numerical simulations and nanoscale atomic force spectroscopy experiments, that sweeping mechanism in formed magnesium hydroxide precipitate is only responsible for D. salina flocculation in hypersaline culture medium upon NaOH addition. Based on this understanding of the flocculation mechanism, we then evaluate the influence of several parameters related to NaOH mixing and magnesium hydroxide precipitation and show that NaOH concentration, mixing, and salinity of the medium can be optimized to achieve high flocculation/flotation harvesting efficiencies in laboratory-scale experiments. We finally successfully scale-up the data obtained at lab-scale to a continuous pre-industrial flotation pilot, and achieve up to 80% of cell recovery. This interdisciplinary study thus provides original results, from the nano to the pre-industrial scale, which allow the successful development of an efficient large-scale D. salina harvesting process. We thus anticipate our results to be the starting point for further optimization and industrial use of this flocculation/flotation harvesting technique.

Gemini surfactant: A novel flotation collector for harvesting of microalgae by froth flotation.

Fecha: Marzo 2019
Fuente: Bioresour Technol. 275:421-424
Autores: Huang Z, Cheng C, Liu Z, Luo W, Zhong H, He G, Liang C, Li L, Deng L, Fu W

Abstract

Froth flotation has been proved to be a promising approach for commercial scale harvesting of microalgae. However, all the surfactants used in the microalgae flotation harvesting process are conventional monomeric surfactants contain a single similar hydrophobic group in the molecule, which results in a low harvesting efficiency. In this work, a novel Gemini surfactant, N,N'-bis(cetyldimethyl)-1,4-butane diammonium dibromide (BCBD) was prepared, and originally recommended as a collector for froth flotation harvesting of Chlorella vulgaris from culture medium. The performance of BCBD was compared with the results acquired using its conventional

monomeric surfactant cetyl trimethyl ammonium bromide (CTAB). The bench-scale flotation results showed that BCBD had excellent collecting power for Chlorella vulgaris. Achieving the obviously superior flotation harvesting performance (flotation recovery increased by 21.4% and enrichment ratio increased by 22.9), the dosage of Gemini type BCBD collector is five times less than that of monomeric CTAB collector.

Buoy-bead flotation harvesting of the microalgae Chlorella vulgaris using surface-layered polymeric microspheres: A novel approach.

Fecha: Noviembre 2018
Fuente: Bioresour Technol. 267:341-346
Autores: Xu K, Zou X, Wen H, Xue Y, Zhao S, Li Y

Abstract

To improve microalgae harvesting efficiency and to reduce the addition of chemicals in the buoy-bead flotation process, a novel buoy-bead flotation approach has been developed for harvesting Chlorella vulgaris, using surface-layered polymeric microspheres (SLPMs). Next, the detachment of microalgae cell-SLPM aggregates and the reusability of SLPMs were investigated. The experimental results showed that a maximum harvesting efficiency of 98.43% was achieved at a SLPM dosage of 0.7 g/L and a pH of 9, and harvesting efficiency quickly decreased with increasing ionic strength. A detachment efficiency of 78.46% and a concentration factor of 19.56 were achieved at an ionic strength of 700 mM and a mixing speed of 3000 rpm without changing the pH. Reused SLPMs can still reach an efficiency of 72.13% after five cycles. The presented results show that this method can potentially be applied for large-scale microalgae harvesting.

Chemically-Induced Production of Anti-Inflammatory Molecules in Microalgae.

Fecha: 30 Noviembre 2019
Fuente: Mar Drugs.
Autores: Montero-Lobato Z, Vázquez M, Navarro F, Fuentes JL, Bermejo E, Garbayo I, Vílchez C, Cuaresma M

Abstract

Microalgae have been widely recognized as a valuable source of natural, bioactive molecules that can benefit human health. Some molecules of commercial value synthesized by the microalgal metabolism have been proven to display anti-inflammatory activity, including the carotenoids lutein and astaxanthin, the fatty acids EPA (eicosapentaenoic acid) and DHA (docosahexaenoic acid), and sulphated polysaccharides. These molecules can accumulate to a certain extent in a diversity of microalgae species. A production process could become commercially feasible if the productivity is high and the overall production process costs are minimized. The productivity of

anti-inflammatory molecules depends on each algal species and the cultivation conditions, the latter being mostly related to nutrient starvation and/or extremes of temperature and/or light intensity. Furthermore, novel bioprocess tools have been reported which might improve the biosynthesis yields and productivity of those target molecules and reduce production costs simultaneously. Such novel tools include the use of chemical triggers or enhancers to improve algal growth and/or accumulation of bioactive molecules, the algal growth in foam and the surfactant-mediated extraction of valuable compounds. Taken together, the recent findings suggest that the combined use of novel bioprocess strategies could improve the technical efficiency and commercial feasibility of valuable microalgal bioproducts production, particularly anti-inflammatory compounds, in large scale processes.

Real time light intensity based carbon dioxide feeding for high cell-density microalgae cultivation and biodiesel production in a bubble column photobioreactor under outdoor natural sunlight.

Fecha: 21 Marzo 2019
Fuente: Bioresour Technol. 284:43-55
Autores: Naira VR, Das D, Maiti SK

Abstract

Outdoor high cell-density microalgae cultivation is highly challenging due to unavailability of appropriate CO2 feeding strategy under diurnal sunlight intensities. Hence, a novel real time light based CO2 feeding strategy was firstly developed under diurnal simulated sunlight (LED) to test on Chlorella sp. in a 10 L scale bubble column photobioreactor. The strategy yielded a biomass titer of 5.12 g L-1 under simulated sunlight, far higher than existing biomass-density and pH-control based CO2 feeding strategies. In outdoor culturing, the proposed feeding strategy yielded high biomass titers of 6.8 and 9.0 g L-1 in growth-phase of two-stage and single-stage lipid induction studies respectively with same biomass productivity of 0.8 g L-1 day-1. Subsequently, two-stage lipid induction strategy of 6.8 g L-1 titer yielded biodiesel productivity of 120 g L-1 day-1, whereas single-stage strategy of 9.0 g L-1 titer was unable to induce lipid. Moreover, specific light availability affects the lipid production.

Knockdown of carbonate anhydrase elevates Nannochloropsis productivity at high CO2 level.

Fecha: 20 Marzo 2019
Fuente: Metab Eng. 54:96-108
Autores: Wei L, Shen C, El Hajjami M, You W, Wang Q, Zhang P, Ji Y, Hu H, Hu Q, Poetsch A, Xu J

Abstract

Improving acid tolerance is pivotal to the development of microalgal feedstock for converting flue gas to biomass or oils. In the industrial oleaginous microalga Nannochloropsis oceanica, transcript knockdown of a cytosolic carbonic anhydrase (CA2), which is a key Carbon Concentrating Mechanism (CCM) component induced under 100 ppm CO2 (very low carbon, or VLC), results in ~45%, ~30% and ~40% elevation of photosynthetic oxygen evolution rate, growth rate and biomass accumulation rate respectively under 5% CO2 (high carbon, or HC), as compared to the wild type. Such high-CO2-level activated biomass over-production is reproducible across photobioreactor types and cultivation scales. Transcriptomic, proteomic and physiological changes of the mutant under high CO2 (HC; 5% CO2) suggest a mechanism where the higher pH tolerance is coupled to reduced biophysical CCM, sustained pH hemostasis, stimulated energy intake and enhanced photosynthesis. Thus "inactivation of CCM" can generate hyper-CO2-assimilating and autonomously containable industrial microalgae for flue gas-based oil production.

Influences of carbon and nitrogen sources and metal ions on the heterotrophic culture of Scenedesmus sp. LX1.

Fecha: 23 Marzo 2019
Fuente: Environ Sci Pollut Res Int.
Autores: He Y, Hong Y, Liu X, Zhang Q, Liu P, Wang S

Abstract

In this study, the influences of organic carbon sources (OCS, including xylose, glucose, maltose, sucrose, and starch) and inorganic and organic nitrogen sources (INS, including ammonia chloride and sodium nitrate; ONS, including arginine, alanine, proline, and valine) and metal ions (including Na+, K+, Mn2+, Zn2+ and Cu2+) on the growth, lipid accumulation, and nitrogen and phosphorus (N&P) removal capabilities of oleaginous Scenedesmus sp. LX1 under heterotrophic conditions were investigated. The results showed that glucose was the only OCS for Scenedesmus sp. LX1 to grow well with specific growth rate of 0.935 days-1, maximum biomass of 1.72 g L-1, and largest removal rates of N&P and organic carbon reaching 72.228%, 93.034%, and 19.208%, respectively. After 11 days of cultivation, the maximal biomass reached in the group with starch or glucose while maximal lipid and triacylglycerol (TAG) yields reached in the groups with maltose and sucrose, respectively. Sodium nitrate was best nitrogen source as the largest algal density,

maximal yields of lipids and TAGs, and highest N&P removal rates reached up to 1.105 × 107 cells·mL-1, 196.70 mg L-1, 5.19 mg L-1, 89.61% and 100%, respectively. Scenedesmus sp. LX1 was found to have great tolerance to Na+, K+, Mn2+, and Zn2+ while 0.5 mg L-1 Cu2+ had a strong inhibition on growth and N&P removal rate of Scenedesmus sp. LX1. Concentration increasing of five metal ions all caused the yield increases of microalgal lipid and TAGs. Graphical abstract.

Effect of light conditions on mixotrophic cultivation of green microalgae.

Fecha: Junio 2019
Fuente: Bioresour Technol. 282:245-253
Autores: Patel AK, Joun JM, Hong ME, Sim SJ

Abstract

Current research aimed to increase mixotrophic biomass from various organic carbon sources by exploring best light conditions. Three substrates glucose, acetic acid and glycerol were studied for their effects on mixotrophic microalgae cultivation under four light conditions. Light irradiance exhibited variability in growth response and photosynthetic efficiency based on type of substrates used in mixotrophic growth. Each substrate showed variability in light requirements for their effective assimilations. From growth responses, glucose and acetic acid respectively exhibited heterotrophic and mixotrophic (better growth in light) natures. Continuous light-deficient condition was adequate for effective mixotrophic growth as well as energy saving for glucose. However, light-sufficient condition required for effective acetic acid supported mixotrophic growth. Mixotrophic benefits from glycerol and its uptake by Chlorella protothecoides was negligible in all light conditions. Investigation of heterotrophic biomass contribution by various substrates in overall mixotrophic yield, glucose offered maximum approx. 43% contribution.

Sequential phototrophic-mixotrophic cultivation of oleaginous microalga Graesiella sp. WBG-1 in a 1000 m2 open raceway pond.

Fecha: 2019
Fuente: Biotechnol Biofuels. 12:27
Autores: Wen X, Tao H, Peng X, Wang Z, Ding Y, Xu Y, Liang L, Du K, Zhang A, Liu C, Geng Y, Li Y

Abstract

Background: Microalgae are an important feedstock in industries. Currently, efforts are being made in the non-phototrophic cultivation of microalgae for biomass production. Studies have shown that mixotrophy is a more efficient process for producing algal biomass in comparison to phototrophic and heterotrophic cultures. However, cultivation of microalgae in pilot-scale open ponds in the presence of organic carbon substrates has not yet been developed. The problems are

heterotrophic bacterial contamination and inefficient conversion of organic carbon. Results: Laboratory investigation was combined with outdoor cultivation to find a culture condition that favors the growth of alga, but inhibits bacteria. A window period for mixotrophic cultivation of the alga Graesiella sp. WBG-1 was identified. Using this period, a new sequential phototrophic-mixotrophic cultivation (SPMC) method that enhances algal biomass productivity and limits bacteria contamination at the same time was established for microalgae cultivation in open raceway ponds. Graesiella sp. WBG-1 maximally produced 12.5 g biomass and 4.1 g lipids m-2 day-1 in SPMC in a 1000 m2 raceway pond, which was an over 50% increase compared to phototrophic cultivation. The bacterial number in SPMC (2.97 × 105 CFU ml-1) is comparable to that of the phototrophic cultivations. Conclusions: SPMC is an effective and feasible method to cultivate lipid-rich microalgae in open raceway ponds. Successful scale-up of SPMC in a commercial raceway pond (1000 m2 culture area) was demonstrated for the first time. This method is attractive for global producers of not only lipid-rich microalgae biomass, but also astaxanthin and β-carotene.

Biomethane from Short Rotation Forestry and Microalgal Open Ponds: System Modeling and Life Cycle Assessment.

Fecha: Febrero 2019
Fuente: Bioresour Technol. 273:468-477
Autores: Tasca AL, Bacci di Capaci R, Tognotti L, Puccini M

Abstract

Gasification of Short Rotation Forestry (SRF) poplar wood chips and anaerobic digestion of the microalga Chlorella vulgaris have been analyzed as alternative supply chains for the production of biomethane. Life Cycle Assessment (LCA) was performed from the biomass cultivation to the upgrading stages. Process simulation of gasification and upgrading was carried out, environmental impacts of the entire supply chains have been estimated and discussed. The highest CO2 removal has been reached by absorption on monoethanolamine. Electricity requirements heavily affect the SRF chain, while productions of carbon dioxide and fertilizers are the main sources of impact of the microalgae cultivation. The recycle of non-absorbed fertilizers, as well as integration of microalgae digestion in wastewater plants, are recommended. Capture and re-injection of the CO2 lost during the upgrading stages would result, simultaneously, in an 8.53% reduction of the atmospheric emission, and in a minor demand to promote algal growth.

Down-Selection and Outdoor Evaluation of Novel, Halotolerant Algal Strains for Winter Cultivation.

Fecha: 2018
Fuente: Front Plant Sci. 9:1513
Autores: Dahlin LR, Van Wychen S, Gerken HG, McGowen J, Pienkos PT, Posewitz MC, Guarnieri MT

Abstract

Algae offer promising feedstocks for the production of renewable fuel and chemical intermediates. However, poor outdoor winter cultivation capacity currently limits deployment potential. In this study, 300 distinct algal strains were screened in saline medium to determine their cultivation suitability during winter conditions in Mesa, Arizona. Three strains, from the genera Micractinium, Chlorella, and Scenedesmus, were chosen following laboratory evaluations and grown outdoors in 1000 L raceway ponds during the winter. Strains were down-selected based on doubling time, lipid and carbohydrate amount, final biomass accumulation capacity, cell size and phylogenetic diversity. Algal biomass productivity and compositional analysis for lipids and carbohydrates show successful outdoor deployment and cultivation under winter conditions for these strains. Outdoor harvest-yield biomass productivities ranged from 2.9 to 4.0 g/m2/day over an 18 days winter cultivation trial, with maximum productivities ranging from 4.0 to 6.5 g/m2/day, the highest productivities reported to date for algal winter strains grown in saline media in open raceway ponds. Peak fatty acid levels ranged from 9 to 26% percent of biomass, and peak carbohydrate levels ranged from 13 to 34% depending on the strain. Changes in the lipid and carbohydrate profile throughout outdoor growth are reported. This study demonstrates that algal strain screening under simulated outdoor environmental conditions in the laboratory enables identification of strains with robust biomass productivity and biofuel precursor composition. The strains isolated here represent promising winter deployment candidates for seasonal algal biomass production when using crop rotation strategies.

Pilot-scale outdoor production of Scenedesmus sp. in raceways using flue gases and centrate from anaerobic digestion as the sole culture medium.

Fecha: Agosto 2018
Fuente: Bioresour Technol. 262:1-8
Autores: Jebali A, Acién FG, Rodriguez Barradas E, Olguín EJ, Sayadi S, Molina Grima E

Abstract

This work investigated the production of Scenedesmus sp. in semi-continuous mode in three pilot-scale outdoor raceways (7.2 m2) using flue gas for CO2 supply and centrate from the anaerobic digestion of urban wastewater as the sole nutrient source. Experiments were performed at

different culture depths, 5, 10 and 15 cm, while evaluating two centrate concentrations (30% and 45%) at dilution rates of 0.2 and 0.3 d-1. Under optimal conditions of 30% centrate, 0.3 d-1 dilution rate and a 15 cm culture depth, a maximum biomass productivity of 22.9 g m-2 d-1 was obtained. The optical properties of the cultures were studied and the results showed a photosynthetic efficiency of up to 2.0% and a quantum yield of 0.3 g biomass E-1. Nitrogen and phosphorus removal rates of 3 g N m-2 d-1 and 0.6 g P m-2 d-1 were recorded, respectively. Lipid productivity of 2.3 g m-2 d-1 was determined possessing a suitable fatty acids profile for biofuel production.

Microalga Scenedesmus bajacalifornicus BBKLP-07, a new source of bioactive compounds with in vitro pharmacological applications.

Fecha: 7 Marzo 2019
Fuente: Bioprocess Biosyst Eng.
Autores: Patil L, Kaliwal BB

Abstract

Microalgae are photosynthetic eukaryotes which are primary producers in the food chain and also excellent sources for bioactive compounds such as alkaloids, flavonoids, phenols, saponins and other fine chemicals. In the present study, the microalga Scenedesmus bajacalifornicus BBKLP-07 was subjected to soxhlet extraction using solvents like chloroform, acetone, ethanol, methanol and aqueous solvents. All the solvents were tested for the presence of phytochemical constituents such as alkaloids, flavonoids, glycosides, phenols, lignin's, saponins, sterols, tannins, anthraquinone and reducing sugar using the standard procedures. Furthermore, all the crude extracts were subjected to antidiabetic, antioxidant, anti-inflammatory and antimicrobial activities. Antidiabetic activity of the microalgal extracts was observed maximum in Aqueous extract. Methanolic extracts have shown maximum antioxidant activity and chloroform extracts have exhibited highest anti-inflammatory effects. Antimicrobial activities were tested against E.coli, S, typhi, C.perfringens and B.subtilis bacteria and fungi A.niger, and C. albicans. Therefore, the green microalga Scenedesmus bajacalifornicus BBKLP-07 is a rich source of biological active compounds and nutraceuticals and can be exploited for commercial applications.

Optimization of lipid extraction from Salvinia molesta for biodiesel production using RSM and its FAME analysis.

Fecha: Julio 2016
Fuente: Environ Sci Pollut Res Int. (14):14047-55
Autores: Mubarak M, Shaija A, Suchithra TV

Abstract

The higher areal productivity and lipid content of microalgae and aquatic weed makes them the best alternative feedstocks for biodiesel production. Hence, an efficient and economic method of extracting lipid or oil from aquatic weed, Salvinia molesta is an important step towards biodiesel production. Since Salvinia molesta is an unexplored feedstock, its total lipid content was first measured as 16 % using Bligh and Dyer's method which was quite sufficient for further investigation. For extracting more amount of lipid from Salvinia molesta, methanol: chloroform in the ratio 2:1 v/v was identified as the most suitable solvent system using Soxhlet apparatus. Based on the literature and the preliminary experimentations, parameters such as solvent to biomass ratio, temperature, and time were identified as significant for lipid extraction. These parameters were then optimized using response surface methodology with central composite design, where experiments were performed using twenty combinations of these extraction parameters with Minitab-17 software. A lipid yield of 92.4 % from Salvinia molesta was obtained with Soxhlet apparatus using methanol and chloroform (2:1 v/v) as solvent system, at the optimized conditions of temperature (85 °C), solvent to biomass ratio (20:1), and time (137 min), whereas a predicted lipid yield of 93.5 % with regression model. Fatty acid methyl ester (FAME) analysis of S. molesta lipid using gas chromatograph mass spectroscopy (GCMS) with flame ionization detector showed that fatty acids such as C16:0, C16:1, C18:1, and C18:2 contributed more than 9 % weight of total fatty acids. FAME consisted of 56.32, 28.08, and 15.59 % weight of monounsaturated, saturated, and polyunsaturated fatty acids, respectively. Higher cetane number and superior oxidation stability of S. molesta FAME could be attributed to its higher monounsaturated content and lower polyunsaturated content as compared to biodiesels produced from C. vulgaris, Sunflower, and Jatropha.

Optimization of continuous lipid extraction from Chlorella vulgaris by CO_2-expanded methanol for biodiesel production.

Fecha: Diciembre 2015
Fuente: Bioresour Technol. 198:550-6
Autores: Yang YH, Klinthong W, Tan CS

Abstract

CO2-expanded methanol (CXM) was used to extract lipids from the microalgae Chlorella vulgaris (a total lipid content of 20.7% was determined by Soxhlet extraction with methanol at 373 K for 96 h) in a continuous mode. The CXM was found to be a superior solvent to methanol, ethanol, pressurized methanol and ethanol, and CO2-expanded ethanol for lipid extraction. The effects of operation variables including temperature, pressure and CO2 flow rate on extraction performance were examined using the response surface and contour plot methodologies. The optimal operating conditions were at a pressure of 5.5 MPa, a temperature of 358 K, a methanol flow rate of 1 mL/min and a CO2 flow rate of 3.0 mL/min, providing an extracted lipid yield of 84.8 wt% over an extraction period of 30 min. Compared with propane methanol mixture, CXM was safer and more energy efficient for lipid extraction from C. vulgaris.

Solid Matrix-Supported Supercritical CO_2 Enhances Extraction of γ-Linolenic Acid from the Cyanobacterium Arthrospira (Spirulina) platensis and Bioactivity Evaluation of the Molecule in Zebrafish.

Fecha: 30 Marzo 2019
Fuente: Mar Drugs.
Autores: Yang X, Li Y, Li Y, Ye D, Yuan L, Sun Y, Han D, Hu Q

Abstract

Marine cyanobacteria represent a large untapped source of functional glycolipids enriched with polyunsaturated fatty acids (PUFAs) for human health. However, advanced methods for scalable isolation of diverse species containing high-purity PUFA-rich glycolipids will have to be developed and their possible pharmaceutical and nutraceutical functions identified. This paper introduces a novel solid matrix-supported supercritical CO_2 extraction method for scalable isolation of the PUFA γ-linolenic acid (GLA)-enriched glycolipids from the cyanobacterium Arthrospira (Spirulina) platensis, which has been the most widely used among microalgae in the nutraceutical and pharmaceutical industries. Of various porous materials studied, diatomite was the best to facilitate extraction of GLA-rich glycolipids, resulting in an extraction efficiency of 98%. Gamma-linolenic acid made up 35% of total fatty acids (TFAs) in the extracts, which was considerably greater than that obtained with ethanol (26%), Bligh and Dyer (24%), and in situ transesterification (24%) methods, respectively. Lipidomics analysis revealed that GLA was exclusively associated with

galactolipids. Pharmaceutical functions of GLA-rich galactolipids were investigated on a zebrafish caudal fin regeneration model. The results suggested that GLA extracted from A. platensis possessed anti-oxidative, anti-inflammatory, and anti-allergic activities, which acted in a concerted manner to promote post-injury regeneration of zebrafish.

Eicosapentaenoic Acid Extraction from Nannochloropsis gaditana using Carbon Dioxide at Supercritical Conditions.

Fecha: 22 Febrero 2019
Fuente: Mar Drugs.
Autores: Molino A, Martino M, Larocca V, Di Sanzo G, Spagnoletta A, Marino T, Karatza D, Iovine A, Mehariya S, Musmarra D

Abstract

This research shows that carbon dioxide supercritical fluid (CO_2-SF) is an emerging technology for the extraction of high interest compounds for applications in the manufacturing of pharmaceuticals, nutraceuticals, and cosmetics from microalgae. The purpose of this study is to recover fatty acids (FAs) and, more precisely, eicosapentaenoic acid (EPA) from Nannochloropsis gaditana biomass by CO_2-SF extraction. In the paper, the effect of mechanical pre-treatment was evaluated with the aim of increasing FAs recovery. Extraction was performed at a pressure range of 250⁻550 bars and a CO_2 flow rate of 7.24 and 14.48 g/min, while temperature was fixed at 50 or 65 °C. The effect of these parameters on the extraction yield was assessed at each extraction cycle, 20 min each, for a total extraction time of 100 min. Furthermore, the effect of biomass loading on EPA recovery was evaluated. The highest EPA extraction yield, i.e., 11.50 mg/g, corresponding to 27.4% EPA recovery, was obtained at 65 °C and 250 bars with a CO_2 flow rate of 7.24 g/min and 1.0 g biomass loading. The increased CO_2 flow rate from 7.24 to 14.48 g/min enhanced the cumulative EPA recovery at 250 bars. The purity of EPA could be improved by biomass loading of 2.01 g, even if recovery was reduced.

Extraction of Bioactive Compounds Using Supercritical Carbon Dioxide.

Fecha: 21 Febrero 2019
Fuente: Molecules
Autores: Molino A, Larocca V, Di Sanzo G, Martino M, Casella P, Marino T, Karatza D, Musmarra D

Abstract

Microalgae Dunaliella salina contains useful molecules such as β-carotene and fatty acids (FAs), which are considered high value-added compounds. To extract these molecules, supercritical carbon dioxide was used at different operative conditions. The effects of mechanical pre-

treatment (grinding speed at 0⁻600 rpm; pre-treatment time of 2.5⁻7.5 min) and operating parameters for extraction, such as biomass loading (2.45 and 7.53 g), pressure (100⁻550 bars), temperature (50⁻75 °C) and CO_2 flow rate (7.24 and 14.48 g/min) by varying the extraction times (30⁻110 min) were evaluated. Results showed that the maximum cumulative recovery (25.48%) of β-carotene was achieved at 400 bars and 65 °C with a CO_2 flow rate of 14.48 g/min, while the highest purity for stage (55.40%) was attained at 550 bars and 65 °C with a CO_2 flow rate of 14.48 g/min. The maximum recovery of FAs, equal to 8.47 mg/g, was achieved at 550 bars and 75 °C with a CO_2 flow rate of 14.48 g/min. Moreover, the lowest biomass loading (2.45 g) and the first extraction cycle (30 min) allowed the maximum extraction of β-carotene and FAs.

Insight on a comprehensive profile of volatile compounds of Chlorella vulgaris extracted by two "green" methods.

Fecha: Marzo 2019
Fuente: Food Sci Nutr. 7(3):918-929
Autores: Lafarge C, Cayot N

Abstract

Some green extraction methods were selected and tested for the extraction of volatile compounds from different samples of the microalga Chlorella vulgaris: ultrasound-assisted liquid-liquid extraction using environment-friendly solvents (LLE) and solid-phase microextraction (SPME). The obtained profiles of volatile chemical compounds were different. Only one molecule was found in common to both extractions. Using the SPME method, the main chemical classes of identified volatile compounds were sulfuric compounds, aldehydes, and alcohols. Using the LLE method, the volatile profile was more balanced with alkanes, fatty acids, terpenes, alcohols, and aldehydes. Multivariate data analyses permitted discrimination among samples. Additionally, the relationship between the physicochemical properties of identified volatile compounds and the methods of extraction was studied. The results showed that the LLE extraction allowed the extraction of volatile compounds having a high boiling point (>160°C) and a high log P (>3). The SPME method was more effective to extract volatile compounds with a low boiling point (<160°C) and a low log P (<3). It is thus necessary to combine several extraction methods to obtain a complete view of the volatile profile for microalgae samples.

Insights in cyanobacteria lipidomics: A sterols characterization from Phormidium autumnale biomass in heterotrophic cultivation.

Fecha: Mayo 2019
Fuente: Food Res Int. 119:777-784
Autores: : Fagundes MB, Falk RB, Facchi MMX, Vendruscolo RG, Maroneze MM, Zepka LQ, Jacob-Lopes E, Wagner R

Abstract

Sterol profiles were obtained from cyanobacteria Phormidium autumnale, cultivated in a heterotrophic system using three distinct sources of carbon: glucose, sucrose, and agroindustrial slaughterhouse wastewater. A simultaneous saponification-extraction ultrasound-assisted method was performed to determine sterol and other non-saponified compounds in the dry biomasses. A total of 24 compounds were observed in the biomasses, including hope-22,29-en-3-one, squalene, and 22 other sterols. Using wastewater as a carbon source, the microalgae biomass produced a diversity of sterols such as stigmasterol (455.3 µg g-1) and β-sitosterol (279.0 µg g-1). However, with glucose it is possible to produce ergosterol (1033.3 µg g-1). Squalene was found in all the cultures, with 1440.4 µg g-1, 225.4 µg g-1, and 425.6 µg g-1 for glucose, sucrose, and slaughterhouse wastewater biomasses, respectively. Several intermediate compounds from those sterols were found. These data provide the construction of the sterol metabolism according to the literature for P. autumnale heterotrophically cultured.

Emerging techniques for cell disruption and extraction of valuable bio-molecules of microalgae Nannochloropsis sp.

Fecha: Febrero 2019
Fuente: Bioprocess Biosyst Eng. 42(2):173-186
Autores: Zhang R, Parniakov O, Grimi N, Lebovka N, Marchal L, Vorobiev E

Abstract

Microalgae of Nannochloropsis sp. present valuable source of bio-molecules (pigments, lipids, proteins) that have nutritional potential for the prevention and treatment of human diseases. Moreover, some species of Nannochloropsis are the promising sources of biofuels and excellent candidates for the replacement of classical biofuel crops. This review describes and compares the efficiency of different conventional and novel techniques that can be used for cell disruption and recovery of bio-molecules from Nannochloropsis sp. Classification of different extraction techniques includes chemical, enzymatic, mechanical and other physical methods. The detailed analysis of extraction efficiency assisted by pressure and temperature (subcritical and supercritical fluids, hydrothermal liquefaction), ultrasound, microwaves, and pulsed electric energy (pulsed electric fields and high voltage electrical discharges) is presented. The general discussion includes comparison between techniques, their effectiveness for cell disruption and selectivity of bio-molecules extraction from Nannochloropsis sp. The cost-effectiveness, benefits and limitations of different techniques are also analyzed.

Response surface optimization of lipid and protein extractions from Spirulina platensis using ultrasound assisted osmotic shock method.

Fecha: Octubre 2018
Fuente: Food Sci Biotechnol. 27(5):1361-1368
Autores: Hadiyanto H, Adetya NP

Abstract

In this study, we optimized the process for extracting lipids and proteins from wet biomasses of Spirulina sp. using a 4-kHz ultrasonic osmotic shock method with ultrasound enhancement at a constant frequency of 40 kHz. Optimization was conducted using a response surface methodology (RSM) at an osmotic NaCl concentration of 10-30%, solvent:biomass ratio of 5-15 v/w, and extraction times of 20-50 min. The present osmotic shock method with ultrasound irradiation increased lipid yields to 6.65% in the presence of 11.9% NaCl, a solvent:biomass ratio of 12:1 v/w, and a 22-min extraction time, and protein yields to 43.96% with 15.12% NaCl, a solvent:biomass ratio of 10:1 v/w, and a 30-min extraction time.

Leptolyngbya fragilis ISC 108 is the most effective strain for dodecane biodegradation in contaminated soils.

Fecha: 1 Abril 2019
Fuente: Int J Phytoremediation.
Autores: Ghanbarzadeh M, Niknam V, Soltani N, Ebrahimzadeh H

Abstract

One of the major environmental problems nowadays is petroleum hydrocarbons contamination. Bioremediation is widely used for cleaning ecosystems contaminated with petroleum hydrocarbons. This study was carried out to investigate the response of five microalgae strains isolated from different regions in Iran for 1% n-dodecane (DOD) degradation. The results revealed that Leptolyngbya fragilis ISC 108 is the most effective strain to utilize n-DOD as growth substrate under a mixotrophic condition. Currently, there is little information about mechanisms involved in microalgae response against DOD. The activity of antioxidant enzymes and total lipid and carbohydrate contents were observed to be greater in DOD-treated L. fragilis ISC 108. Lower values of lipid peroxidation and H2O2 along with an increase of dry weight and specific growth rate in L. fragilis ISC 108 under DOD treatment shows that at the cellular level this strain is better equipped with an efficient oxygen radical scavenging system. In conclusion, this study proposes that L. fragilis ISC 108 can be considered an ideal candidate for use in bioremediation of DOD contaminated sites.

Physiological Properties of Photoautotrophic Microalgae and Cyanobacteria Relevant to Industrial Biomass Production.

Fecha: 29 Marzo 2019
Fuente: Mar Biotechnol (NY).
Autores: Tsuzuki M, Okada K, Isoda H, Hirano M, Odaka T, Saijo H, Aruga R, Miyauchi H, Fujiwara S

Abstract

Photoautotrophic mass culture of microalgae is currently under investigation for social implementation, since such organisms are anticipated to be resources of alternative fuels and materials for reducing global warming. Production scale-up of culture systems and economy balance are great barriers for practical usage. In order to develop new culture systems such as attachment on solid surfaces or biofilms, we investigated various characteristics of photosynthesis in Chlorella, not only in liquid but also on filter membranes. In aquatic cultures, the photosynthetic rate was almost the same as the specific exponential growth rate at over 32 °C, suggesting that highly efficient cell growth was achieved at that temperature. The algal cells could fix about 50 mmol carbons per mole photons, at cloudy-day-level light intensities, which result to produce 1.2 g dry cell weight in calculation. Moreover, Chlorella could grow on a membrane surface at almost the same rate as in liquid. Similar tolerance to water deficiency was observed in a cyanobacterium, Synechocystis, in which gene expression responded in 30 min after the stress. Such a tolerance was also observed in other species of microalgae and cyanobacteria in photosynthesis.

Effects of sugarcane bagasse hydrolysate (SCBH) on cell growth and fatty acid accumulation of heterotrophic Chlorella protothecoides.

Fecha: 27 Marzo 2019
Fuente: Bioprocess Biosyst Eng.
Autores: Chen JH, Liu L, Lim PE, Wei D

Abstract

Microalgal lipid production by Chlorella protothecoides using sugarcane bagasse hydrolysate was investigated in this study. First, maximum glucose and reducing sugar concentrations of 15.2 and 27.0 g/L were obtained in sugarcane bagasse hydrolysate (SCBH), and the effects of different percentages of glucose and xylose on algal cultivation were investigated. Afterwards, SCBH was used as a carbon source for the cultivation of C. protothecoides and higher biomass concentration of 10.7 g/L was achieved. Additionally, a large amount of fatty acids, accounting up to 16.8% of dry weight, were accumulated in C. protothecoides in the nitrogen-limited (0.1-1 mmol/L) culture. Although SCBH inhibited fatty acid accumulation to a certain degree and the inhibition was aggravated by nitrogen starvation, SCBH favored microalgal cell growth and fatty acid production.

The present study is of significance for the integration of cost-effective feedstocks production for biodiesel with low-cost SCBH as well as environmentally friendly disposal of lignocellulosic wastes.

Transcriptome analysis reveals the genetic foundation for the dynamics of starch and lipid production in Ettlia oleoabundans

Fecha: Julio 2018
Fuente: Algal Research, Volume 33
Autores: Mark H.J. Sturme, Yanhai Gong, Josué Miguel Heinrich, Anne J. Klok, Gerrit Eggink, Dongmei Wang, Jian Xu, Rene H. Wijffels

Abstract

The oleaginous microalga Ettlia oleoabundans accumulates both starch and lipids to high levels under stress conditions such as nitrogen starvation (N−). To steer biosynthesis towards starch or lipids only, it is important to understand the regulatory mechanisms involved. Here physiological and transcriptional changes under nitrogen starvation were analysed in controlled flat-panel photobioreactors at both short and long time-scales. Starch accumulation was transient and occurred rapidly within 24 h upon starvation, while lipid accumulation was gradual and reached a maximum after 4 days. The major fraction of accumulated lipids was composed of de novo synthesized neutral lipids - triacylglycerides (TAG) - and was characterized by a decreased composition of the polyunsaturated fatty acids (PUFAs) C18:3 and C16:3 and an increased composition of the mono-unsaturated (MUFAs) and saturated (SFAs) fatty acids C18:1/C16:1 and C18:0/C16:0, respectively. RNA-sequencing revealed that starch biosynthesis and degradation genes show different expression dynamics from lipid biosynthesis ones. An immediate rapid increase in starch synthetic transcripts was followed by an increase in starch degrading transcripts and a decrease in the starch synthetic ones. In contrast, increased gene expression for fatty acid and TAG synthesis was initiated later and occurred more gradually. Expression of several fatty acid desaturase (FAD) genes was decreased upon starvation, which corresponds to the observed changes to higher levels of MUFAs and SFAs. Moreover, several homologs of transcription regulators that were implicated in controlling starch and lipid metabolism in other microalgae showed differential gene expression and might be key regulators of starch and lipid metabolism in E. oleoabundans as well. Our data provide insights into the genetic foundation of starch and lipid metabolism in E. oleoabundans under nitrogen starvation and should facilitate metabolic engineering towards tailored strains with desired storage compound composition.

Chloroplast engineering of Chlamydomonas reinhardtii to use phosphite as phosphorus source

Fecha: Julio 2018
Fuente: Algal Research, Volume 33
Autores: José M. Sandoval-Vargas, Karla S. Macedo-Osorio, Noé V. Durán-Figueroa, Claudio Garibay-Orijel, Jesús A. Badillo-Corona

Abstract

Phosphorus (P) is a key biological element and a limiting nutrient in aquatic and terrestrial environments. The vast majority of organisms can only uptake phosphorus in its most oxidized form, as phosphate ($PO4^{3-}$), whereas a few prokaryotic species can metabolize phosphorus in a more reduced state such as phosphite ($PO3^{3-}$). Recently, it has been shown that by expressing the ptxD gene, encoding a NAD-dependent phosphite dehydrogenase (also known as phosphonate dehydrogenase), in Chlamydomonas reinhardtii phosphite utilization can be enabled. However, this was done by transforming the nuclear genome, where gene silencing is frequent and random integration of transgenes can result in variable levels of gene expression and pleiotropic effects. The aim of this work was to investigate if phosphite assimilation in the eukaryotic algae Chlamydomonas reinhardtii can also be achieved by expressing a codon-optimized ptxD gene in the chloroplast. To do this, the ptxD gene was targeted and stably integrated into the psbA exon 5-5S rRNA intergenic region within the inverted repeats of the C. reinhardtii chloroplast genome. Integration was shown to occur in the targeted site and transplastomic lines were shown to be homoplasmic and to stably accumulate the NAD-dependent phosphite dehydrogenase PTXD, enabling the cells to use phosphite as the sole phosphorus source in a 0.1–5 mM concentration range. This work demonstrates that transplastomic lines of C. reinhardtii expressing the prokaryotic ptxD gene can effectively be cultivated in phosphite, opening new opportunities for microalgae cultivation.

Exergy efficiency of solar energy conversion to biomass of green macroalgae Ulva (Chlorophyta) in the photobioreactor

Fecha: 1 Julio 2018
Fuente: Energy Conversion and Management, Volume 167
Autores: Meiron Zollmann, Hadar Traugott, Alexander Chemodanov, Alexander Liberzon, Alexander Golberg

Abstract

Offshore production of macroalgae biomass, which was recently given the name seagriculture, is one of the important but least explored alternative energy resources. Unlike microalgae, macroalgae cultivation can be done offshore and therefore brings real news to the biofuel – food

land agriculture conflict. A wide variety of small-scale laboratory experiments are done lately in order to deepen the knowledge and develop expertise in macroalgae cultivation and its downstream processing. For energy applications, it is common to evaluate the performance of an energy source or system in exergy efficiency terms. Another important parameter that is evaluated to determine the system's environmental impact is it's volumetric and areal footprint. The current work examines two exergy efficiency indexes, the Exergy Efficiency (EE), which takes into account all exergy inputs, and the Exergy Return On Investment (ExROI), that includes only fossil fuel exergy inputs, both on a green macroalgae Ulva grown in the macroalgae photobioreactor system (MPBR) incorporated into a building. Cultivation of macroalgae in the building embedded MPBR achieved maximal values of 0.012 and 0.22 for EE and ExROI, compared to a range of 0.05–8.34 and 0.013–0.327 found in published papers of microalgae systems. In addition, a modelled optimization of the initial biomass density leads to maximal values of about 0.035 for EE and 0.433 for ExROI, while further improvement may be achieved by optimization of nutrient addition and mixing methodology. This work demonstrates a tool to measure the performance of laboratory scale macroalgae biomass cultivation systems, followed by preliminary efficiency and environmental impact values, important for future upscaling.

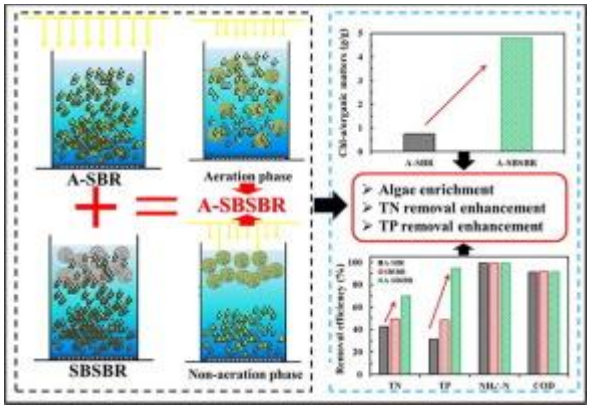
Performance and mechanism of a novel algal-bacterial symbiosis system based on sequencing batch suspended biofilm reactor treating domestic wastewater

Fecha: Octubre 2018
Fuente: Bioresource Technology, Volume 265
Autores: Cong-Cong Tang, Yu Tian, Zhang-Wei He, Wei Zuo, Jun Zhang

Abstract

A novel algal-bacterial symbiosis system based on sequencing batch suspended biofilm reactor (A-SBSBR) was developed for simultaneously enhanced nitrogen (N) and phosphorus (P) removal from domestic wastewater. Results showed that the total N (TN) and P (TP) removal efficiencies in A-SBSBR increased to 69.91% and 94.78%, respectively. The mechanism analysis indicated that TN removal mainly occurred at non-aeration stage, and TP removal happened during the whole cycle in A-SBSBR. Compared to control SBSBR, TN removal by denitrification and anabolism and TP removal by anabolism in A-SBSBR increased by 12.70%, 7.64% and 50.13%, respectively. The Chlorophyll a accumulation in biofilm increased to 4.80 ± 0.08 mg/g. Algae related to Chlorella and Scenedesmus and bacteria related to Flavobacterium, Micropruina and Comamonadaceae were enriched in A-SBSBR and responsible for the enhanced nutrients removal effect. This study may provide a new solution to achieve nutrients removal enhancement from wastewater.

Graphical abstract



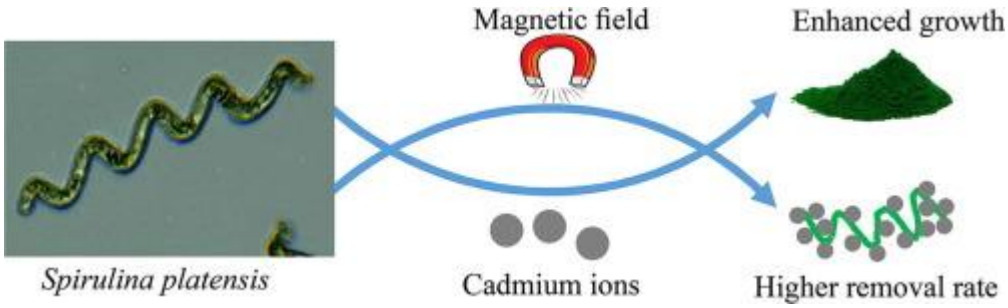
Enhancement of Spirulina biomass production and cadmium biosorption using combined static magnetic field

Fecha: Octubre 2018
Fuente: Bioresource Technology, Volume 265
Autores: Weilan Shao, Reham Ebaid, Abd El-Fatah Abomohra, Mohamed Shahen

Abstract

The effect of static magnetic field (SMF) on Spirulina platensis growth and its influence on cadmium ions (Cd^{2+}) removal efficiency were studied. Application of 6 h day^{-1} SMF resulted in the highest significant biomass productivity of 0.198 g L^{-1} day^{-1}. However, 10 and 15 mg L^{-1} of Cd^{2+} resulted in significant reduction in biomass productivity by 8.8 and 12.5%, respectively, below the control. Combined SMF showed 30.1% significant increase in biomass productivity over the control. On the other hand, increase of initial Cd^{2+} concentration resulted in significant reduction of Cd^{2+} removal efficiency, representing 79.7% and 61.5% at 10 and 15 mg L^{-1}, respectively, after 16 days. Interestingly, application of SMF for 6 h day^{-1} enhanced Cd^{2+} removal efficiency counted by 91.4% and 82.3% after 20 days for cultures with initial Cd^{2+} concentration of 10 and 15 mg L^{-1}, representing increase by 6.3 and 25.3%, respectively, over the SMF-untreated cultures.

Graphical abstract



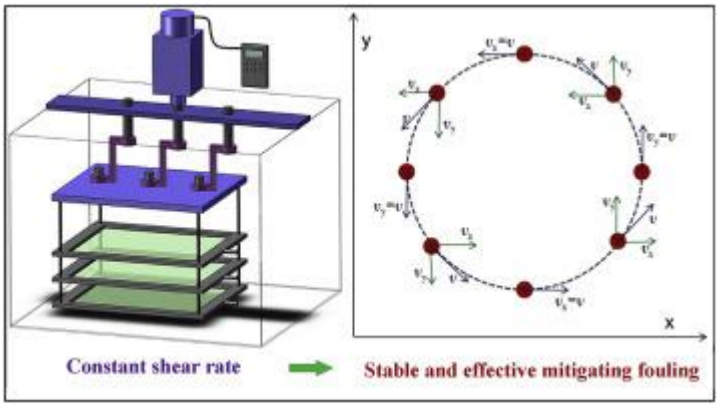
A uniform shearing vibration membrane system reducing membrane fouling in algae harvesting

Fecha: 20 Septiembre 2018
Fuente: Journal of Cleaner Production, Volume 196
Autores: Fangchao Zhao, Yalei Zhang, Huaqiang Chu, Shuhong Jiang, Zhenjiang Yu, Miao Wang, Xuefei Zhou, Jianfu Zhao

Abstract

When a membrane is used to harvest algae, membrane fouling caused by algae and extracellular organic matter (EOM) is a serious challenge. A uniform shearing vibration membrane (USVM) system was devised and applied to reducing membrane fouling in algae filtration. The shear rate produced by USVM is constant because of its uniform circular motion; thus, USVM could stably and significantly mitigate fouling. During the filtration experiments where the frequency was increased from 1 to 5 Hz, the transmembrane pressure (TMP) visibly reduced. Even at a relatively low frequency of 5 Hz, USVM still could stably filter algae and had only slight membrane fouling. Increasing the vibration frequency not only could significantly reduce reversible membrane fouling but could also reduce irreversible membrane fouling. Protein could cause more serious reversible membrane fouling, while humic substances could lead to more serious irreversible membrane fouling. In this study, USVM effectively reduced the deposition of algae cells, protein, polysaccharide and humic substances on the membrane as frequency increased.

Graphical abstract



Modeling the influence of initial density and copper exposure on the interspecific competition of two algal species

Fecha: 10 Septiembre 2018
Fuente: Ecological Modelling, Volume 383
Autores: Yongeun Kim, Jino Son, Hyoung-Ho Mo, Yun-Sik Lee, Kijong Cho

Abstract

The interspecific competition among algal species is an important process that can change the community structure in aquatic ecosystems. However, there is still a lack of understanding of the impact of various factors on interspecific competition. In this study, both experimental and mathematical modeling approaches were employed to investigate how various combinations of the initial cell densities of Pseudokirchneriella subcapitata and Chlorella vulgaris and copper exposure levels affect interspecific competition between these species. In the simulation results, C. vulgaris appeared to be superior to P. subcapitata in the absence of copper exposure. However, in the copper-exposed groups, the competitive positions of both algal species varied with the initial cell density and the copper exposure level. In particular, at the highest copper concentration (10 μg/L), C. vulgaris became less competitive than P. subcapitata in most initial cell density combinations, resulting in a shift in competitive dominance. This study clearly showed that the dominant species in the interspecific competition could be altered by the two factors studied herein. The developed model provided a more detailed and intuitive understanding of the effects of the two factors on the interspecific competition by simulating the competition at various combinations of initial algal density and copper exposure levels. In this study, the initial algal density and copper exposure levels were selected as the factors influencing the interspecific competition between P. subcapitata and C. vulgaris, but the proposed model could be used to study the effects of other toxicants on the interspecific competition between other algal species.

Effect of combining adsorption-stripping treatment with acidification on the growth of Chlorella vulgaris and nutrient removal from swine wastewater

Fecha: Septiembre 2018
Fuente: Bioresource Technology, Volume 263
Autores: Leipeng Cao, Ting Zhou, Zihan Li, Jingjing Wang, Juan Tang, Roger Ruan, Yuhuan Liu

Abstract

After swine wastewater (SW) was treated with adsorption-stripping stage, the concentration of $NH4^{+}$-N and Total phosphorus (TP) in SW significantly decreased from 598.04, 42.95 to 338.02, 8.36 mg L^{-1}, respectively. The concentration of heavy metals, especially Zn^{2+} (96.78%), decreased

by the ion exchange of artificial zeolite (AZ). The acidification of SW could significantly improve the nutrient utilization efficiency and promote the growth rate of C. vulgaris due to the hydrolysis of macromolecular substances into smaller molecules usable for algae. By combining adsorption (Part I), stripping (Part II) and cultivation (Part III), the highest removal rates of $NH4^{+}$-N, TP, chemical oxygen demand (COD) and total organic carbon (TOC) from SW were 80.50, 96.90, 72.91, and 84.17%, respectively, and the OD680 value was 1.129 (1.48 times of control) at pH 6.0. The combined system (Part I–III) can significantly enhance the removal efficiency of nutrient and biomass production by acidification.

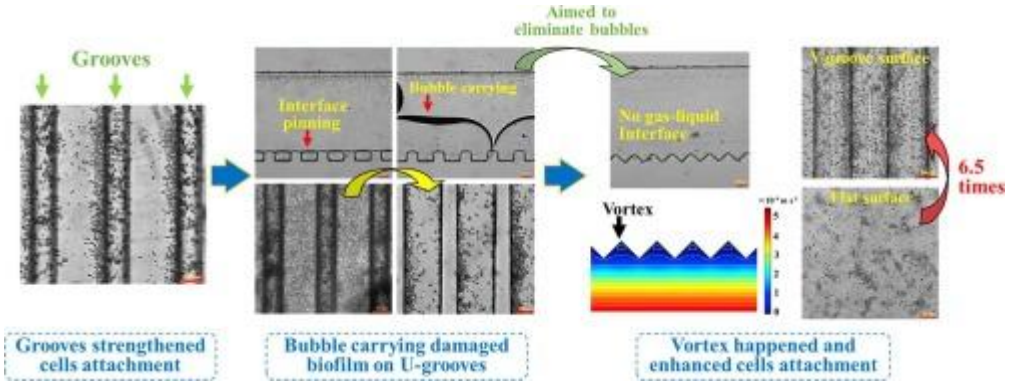
Enhancing microalgae biofilm formation and growth by fabricating microgrooves onto the substrate surface

Fecha: Agosto 2018
Fuente: Bioresource Technology, Volume 261
Autores: Yun Huang, Yaping Zheng, Jun Li, Qiang Liao, Qian Fu, Ao Xia, Jingwei Fu, Yahui Sun

Abstract

Attachment of cells to substrate surface is the premise for biofilm formation. To shelter microalgae cells from fluid shear stress and offer larger areas for microalgae attachment, the inerratic microgrooves, which can act as anchor points that offer larger areas for microalgae attachment and induce vortex to protect cells from hydraulic shear stress, were designed and fabricated into substrate surface. The results indicated that the shear stress on the surface with V-grooves was weaker than that on the surface with U-grooves, and 45° V-grooves with the width of 200 μm were benefit for cells attachment. The initial attachment time was shortened to 50 min under the hydraulic shear stress of 0.02 Pa compared to that of 135 min on the surface without microgrooves. Subsequently, the biofilm biomass concentration on the surface with 45° V-grooves increased by 14.29% to 165.84 g m^{-2} compared with that on flat substrates.

Graphical abstract



Numerical study of liquid mixing in microalgae-farming tanks with baffles

Fecha: 1 Agosto 2018
Fuente: Ocean Engineering, Volume 161
Autores: Bang-Fuh Chen, Hung-Kai Yang, Chih-Hua Wu, Tzu-Chiang Lee, Bing Chen

Abstract

One possible renewable energy source is microalgal biomass, representing sunlight-driven cell factories. Experimental studies have shown that a uniform mixture of microalgae is required for their access to sunlight. Generally, running paddlewheels for raceway ponds and mechanical pumps for photobioreactors are used, and their electricity consumption increases the costs of algae-mediated biodiesel production. To reduce the consumption of electricity, we developed the idea of using a floating automatic mix system based on the mixing nature of liquid sloshing in a baffled tank floating in the ocean. When oscillatory water waves induce liquid sloshing in the tank, vortices form and shedding is generated by horizontal baffles installed in the tank. Wave motions may be employed to enhance the mixing of microalgae in the tank and dramatically reduce the electricity consumption that is required in traditional algae-mediated biodiesel production. The vortex generation of sloshing liquids in a tank with horizontal baffles was numerically and experimentally investigated in this study. The effects of baffle location and length were systematically studied. The study and application of liquid sloshing in a tank with baffles are usually used to tune liquid dampers for vibration control of a structure. The particles movement and mixing in the tank are seldom discussed. The simulation results found in this study introduce a new application for liquid sloshing in a tank with baffles. Appropriately allocated horizontal baffles in the tank can significantly enhance the mixing of liquid particles and can be applied in microalgae cultivation.

Dewatering algae using an aquaporin-based polyethersulfone forward osmosis membrane

Fecha: 2 Octubre 2018
Fuente: Separation and Purification Technology, Volume 204
Autores: Faris M. Munshi, Jared Church, Rebecca McLean, Nicholas Maier, A.H.M. Anwar Sadmani, Steven J. Duranceau, Woo Hyoung Lee

Abstract

Low energy requirement in algae harvesting is necessary for sustainable biofuel production. Forward osmosis (FO) can provide a potential alternative for low energy consumption by using

osmotic pressure between the draw solution (DS) and feed solution (FS). In this study, an aquaporin-based polyethersulfone (PES) membrane was evaluated for algal dewatering using FO. Three different types of DS (NaCl, KCl and NH4Cl), different cross flow velocities (CFVs), and configuration variations were compared to determine the FO performance to dewater Chlorella vulgaris. For short-term operation (500 min), the average water fluxes were 5.6, 4.8, and 4.3 L m^{-2} h^{-1} for NaCl, KCl, and NH4Cl, respectively and all DSs showed increased fluxes with increased CFVs. In particular, this study found that NH4Cl is the best candidate among the three tested DSs for improved water flux and low reverse salt flux for the aquaporin-based PES FO membrane. Natural seawater was also tested and revealed well-defined DS performance compatible with NaCl. For a longer duration experiment, 81% of algae dewatering was achieved with a 29% flux drop which may be attributed to the increasing FS concentration, concentration polarization and the loosely attached algal biofilm on the membrane surface. Overall, this study demonstrates a new iteration of the aquaporin-based PES membrane for algal dewatering in FO application.

Graphical abstract

A newer approach for the primary extraction of allophycocyanin with high purity and yield from dry biomass of Arthrospira platensis

Fecha: 2 Octubre 2018
Fuente: Separation and Purification Technology, Volume 204
Autores: Hrishikesh A. Tavanandi, A. Chandralekha Devi, KSMS. Raghavarao

Abstract

Conventional extraction methods are able to extract only 50–60% of the total allophycocyanin (A-PC) present in a given biomass. One of the reasons is the resistance offered by the cell membrane for its disruption. The present study is aimed at screening different conventional methods and their combinations (to explore synergy) to arrive at the most suitable methodology for the primary

extraction of A-PC from dry biomass of Arthrospira platensis. A synergistic effect was observed on employing ultrasonication in combination with other conventional methods. Ultrasonication with freezing and thawing resulted in the highest A-PC extraction efficiency of 93.11%. The problem of purification of A-PC when extracted along with c-phycocyanin (C-PC), due to same biochemical properties, could be overcome by carrying out 'ultrasonication followed by sequential extraction employing freezing and thawing'. A-PC with an yield of 40% (devoid of C-PC) with a purity of 1.15 could be extracted, the highest reported till date during primary extraction itself.

Numerical simulation on promoting light/dark cycle frequency to improve microalgae growth in photobioreactor with serial lantern-shaped draft tube

Fecha: Octubre 2018
Fuente: Bioresource Technology, Volume 266
Autores: Qing Ye, Jun Cheng, Wangbiao Guo, Junchen Xu, Hui Li, Junhu Zhou

Abstract

Computational fluid dynamics were employed to simulate microalgal cells movement with enhanced flash-light effects in a gaslift loop-current column photobioreactor (GLCP) with serial lantern-shaped draft tube (LDT). Clockwise and anticlockwise vortexes were formed in outer down-flow region of GLCP with LDT. The radial velocity, axial velocity, and turbulent kinetic energy of microalgal solution appeared periodical change around the lanterns. The average radial velocity showed a sixfold improvement from 0.003 m/s to 0.021 m/s, and average turbulent kinetic energy was enhanced by 18.2% from 22.5×10^{-4} m^2/s^2 to 26.6×10^{-4} m^2/s^2, thus increasing light/dark cycle frequency by 54%. The light/dark cycle frequency increased first and then decreased with an increase of individual lantern height. The increased lantern number promoted the light/dark cycle frequency and light time ratio. Microalgal biomass yield in the GLCP with LDT was improved by 30%, and CO2 fixation peak rate was promoted by 35%.

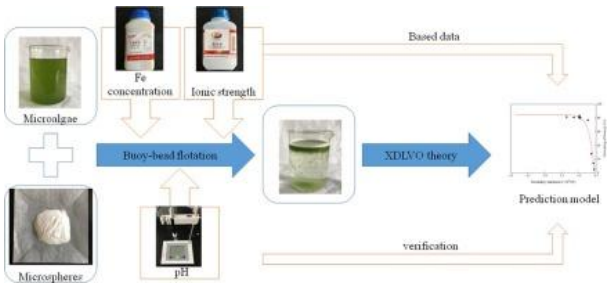
Investigating microalgae cell-microsphere interactions during microalgae harvesting by ballasted dissolved air flotation through XDLVO theory

Fecha: 15 Septiembre 2018
Fuente: Biochemical Engineering Journal, Volume 137
Autores: Kaiwei Xu, Yanpeng Li, Xiaotong Zou, Hao Wen, Zhou Shen, Xiangying Ren

Abstract

Ballasted dissolved air flotation (BDAF) method is an innovative and efficient technology for harvesting microalgae. However, this flotation process is not yet fully understood. In this study, surface properties of Scenedesmus obliquus (S. obliquus), Chlorella vulgaris (C. vulgaris) and microspheres were characterized by Zeta potential and contact angle measurements, and then the attachment behavior of the microalgae cells on microspheres was investigated by thermodynamic and extended Derjaguin-Landau-Verwey-Overbeek (XDLVO) theory approaches. The calculated results revealed that the van der Waals (vdW) interaction played an important role in determining the net attraction between the microalgae cell and the microsphere, while the Lewis acid-base (AB) interaction was always repulsion. Microalgae harvesting efficiency could be significantly improved by adding ferric chloride and lowering the pH value because the electrostatic (ES) interaction changed from repulsion to neutralization, and even to attraction, while the vdW and the AB interactions remained almost unchanged. The XDLVO analysis indicated that there was an effective attachment with a secondary minimum of -0.548×10^3 kT for S. obliquus-microsphere system and -0.744×10^3 kT for C. vulgaris-microsphere system. The deeper the well depth of secondary minimum, the better the attachment of microalgae cells to microspheres, which may result in a better harvesting efficiency. Finally, a suitable XDLVO prediction model was proposed to describe the relationship between microalgae cell-microsphere interactions and harvesting efficiency of BDAF.

Graphical abstract



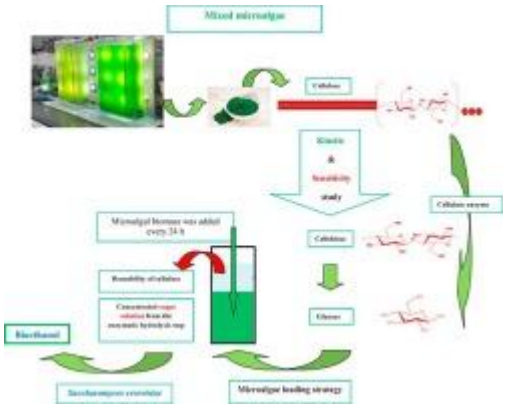
Enzymatic hydrolysis of microalgal cellulose for bioethanol production, modeling and sensitivity analysis

Fecha: 15 Septiembre 2018
Fuente: Fuel, Volume 228
Autores: Hanieh Shokrkar, Sirous Ebrahimi, Mehdi Zamani

Abstract

A kinetic model was developed to describe the enzymatic hydrolysis of microalgal cellulose. In the kinetic model, the factors including product inhibition, temperature, and pH were considered. This model combined two reactions for hydrolyzing algal cellulose to cellobiose and glucose and one reaction for cellobiose breakdown to glucose. Results showed that the highest glucose yield (57%) was achieved at microalgal biomass concentration of 50 g/L, pH 5, and temperature of 50 °C. Moreover, the sensitivity analysis was carried out on each kinetic model parameter. This analysis indicated that k 3 ′ and km3 in reaction R3 (cellobiose to glucose) are the most influential parameters during enzymatic hydrolysis of algal cellulose. Finally, the microalgal biomass loading experiment demonstrated that cellulase could be used thrice without compromising on the glucose yield. Fermentation of concentrated sugar medium with Saccharomyces cerevisiae produced ethanol (12.87 g/L) with yield (0.46 g ethanol/g glucose).

Graphical abstract



Potential of using sodium bicarbonate as external carbon source to cultivate microalga in non-sterile condition

Fecha: Octubre 2018
Fuente: Bioresource Technology, Volume 266
Autores: Zemin Tu, Liangting Liu, Weitie Lin, Zhangzhang Xie, Jianfei Luo

Abstract

In this study, a saline-alkaline tolerant microalgal strain was isolated and identified as Chlorella sp. LPF. This strain was able to grow at pH values up to 10 and at salinities up to 5%, and tolerated to 80 g L^{-1} of sodium bicarbonate. The utilization of bicarbonate as carbon source significantly promoted microalgal growth and lipid production. In the non-sterile cultivation supplying with 80 g L^{-1} of sodium bicarbonate, the microalgal growth had no difference with their growth in the sterile medium; however, the bacterial growth was suppressed and the cell number decreased to low levels after six days cultivation. This study gives an insight into the potential that using high concentration of sodium bicarbonate as external carbon source to cultivate microalga in non-sterile condition, and suggests a possibility of using bicarbonate as growth promoter and antibacterial agent for the microalgal outdoor cultivation.

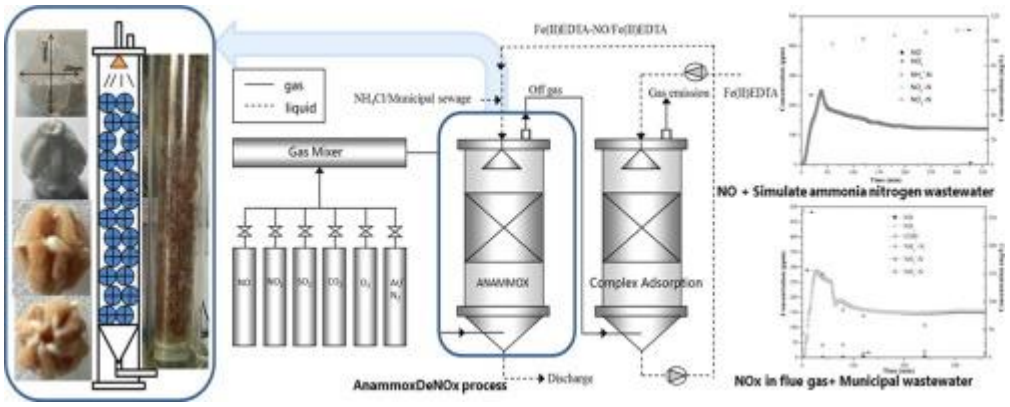
Nitric oxide removal from flue gas with ammonium using AnammoxDeNOx process and its application in municipal sewage treatment

Fecha: Octubre 2018
Fuente: Bioresource Technology, Volume 265
Autores: Xiaojing Wang, Xiaochen Xu, Yu Zou, Fenglin Yang, Yun Zhang

Abstract

A novel AnammoxDeNOx process was designed to simultaneously remove NOx in flue gas and ammonium wastewater, with the aim of exploring the possibility of using NO as a long-term and stable electron acceptor for anammox bacteria. The performance of the AnammoxDeNOx process indicated a NOx removal efficiency from simulated flue gas (including CO2, SO2, O2 and NO2) of 87–96% using simulated ammonium wastewater. With municipal wastewater, the removal efficiencies for NOx were 70–90%, total nitrogen 40–70%, and COD 80–90% (NO concentration: 100–500 ppm). The anammox genus underwent considerable changes from the dominant Candidatus Kuenenia in the stage of domestication to the predominant Candidatus Brocadia, which then became the dominant species in the simulated flue gas and actual municipal wastewater stages.

Graphical abstract



Innovative polyhydroxybutyrate production by Chlorella fusca grown with pentoses

Fecha: Octubre 2018
Fuente: Bioresource Technology, Volume 265
Autores: A.P.A. Cassuriaga, B.C.B. Freitas, M.G. Morais, J.A.V. Costa

Abstract

The current study aimed to evaluate if the addition of pentoses along with variations in light intensity and photoperiod can stimulate the production of polyhydroxybutyrate (PHB) and other biomolecules by Chlorella fusca LEB 111. The variables evaluated were the addition of xylose and arabinose as sources of organic carbon, different photoperiods (18 h, 12 h and 6 h light) and variations in light intensities (58, 28 and 9 µmolphotons m^{-2} s^{-1}). The highest PHB accumulation (17.4% w w^{-1}) and protein production (53.2% ww^{-1}) were observed in assays with xylose addition and a photoperiod of 6 h of light provided at 28 and 58 µmolphotons m^{-2} s^{-1}, respectively. The highest lipid content (24.7% w w^{-1}) was obtained with 18 h of light. The current study contributes to the development of sustainable alternatives for the use of wastes and the production of biomolecules from algae.

Integrated microalgae biomass production and olive mill wastewater biodegradation: Optimization of the wastewater supply strategy

Fecha: 1 Octubre 2018
Fuente: Chemical Engineering Journal, Volume 349
Autores: Fabrizio Di Caprio, Pietro Altimari, Francesca Pagnanelli

Abstract

Olive mill wastewater (OMW) was supplied to Scenedesmus sp. cultures to simultaneously achieve biomass production and wastewater biodegradation. Two OMW supply strategies were implemented to prevent the reduced growth performances that are attained, compared to photoautotrophic cultivation, when OMW is supplied at the beginning of cultivation (batch strategy). A fed-batch strategy including the gradual OMW supply yielded a biomass production equal to 0.86 g/L, while 1.4 g/L was attained by a two-stage strategy including OMW addition during nitrogen-starvation. OMW enhanced the carbohydrate accumulation (up to 44%) through the removal of OMW sugars (60–70%). About 55% OMW phenol removal was achieved by the fed-batch strategy when the phenol concentration was lower than 100 mg/L, and by the two-stage strategy when the heterotrophic stage lasted longer than 8–10 days. The illustrated results indicate that the OMW supply strategy can be purposefully tailored to regulate biomass production and OMW biodegradation.

Continuous cultivation of Chlorella minutissima 26a in a tube-cylinder internal-loop airlift photobioreactor to support 3G biorefineries

Fecha: Enero 2019
Fuente: Renewable Energy, Volume 130
Autores: Geronimo Virginio Tagliaferro, Hélcio José Izário Filho, Anuj Kumar Chandel, Silvio Silvério da Silva, Messias Borges Silva, Júlio César dos Santos

Abstract

Microalgae Chlorella minutissima 26a was cultivated in a tube-cylinder internal-loop airlift photobioreactor under continuous cultivation conditions. The goal was to investigate the influence of different nitrate levels on the growth and composition of microalgae. Three nitrate concentrations (75, 150 and 225 mg L^{-1}) were assessed under a fixed flow rate and the outlet flow was analyzed for concentration of biomass, lipid, carbohydrate and protein. Nitrate concentration at higher level (225 mg L^{-1}) in the medium promoted biomass growth (188.6 mg L^{-1} d^{-1}) and lipid production (92.8 mg L^{-1} d^{-1}), and decreased carbohydrate amount (29.1 mg L^{-1} d^{-1}) without any change in protein content (37.7 mg L^{-1} d^{-1}). Use of tube-cylinder internal-loop airlift photobioreactor in continuous mode could be a promising approach in algal biorefineries so called 3G biorefineries, resulting in high biomass productivity in a simple cultivation system.

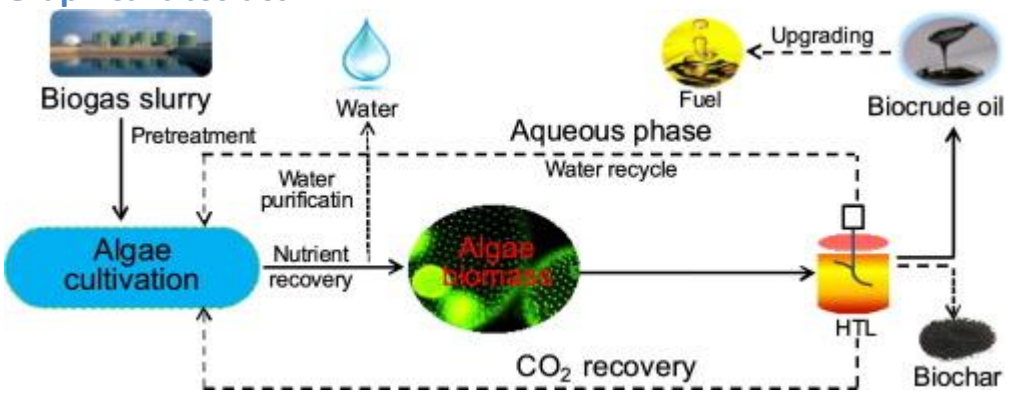
Biogas liquid digestate grown Chlorella sp. for biocrude oil production via hydrothermal liquefaction

Fecha: 1 Septiembre 2018
Fuente: Science of The Total Environment, Volume 635
Autores: Hugang Li, Meng Wang, Xinfeng Wang, Yuanhui Zhang, Haifeng Lu, Na Duan, Baoming Li, Dongming Zhang, Taili Dong, Zhidan Liu

Abstract

Microalgae can not only purify and recover the nutrients from wastewater, but also be harvested as wet biomass for the production of biocrude oil via hydrothermal liquefaction (HTL). Chlorella sp. cultivated in the ultrafiltration (UF) membrane treated anaerobic digestion (AD) liquid digestate of chicken manure was used as the feedstock in this study. The present study characterized the products and investigated the elemental migration during HTL of Chlorella sp. fed with AD effluent wastewater (WW) and BG11 standard medium (ST) in 100mL and 500mL reactors under different operational conditions. Results showed that the highest oil yield of WW (38.1%, daf) was achieved at 320°C, 60min and 15% TS in 500mL reactor, which was 14.1% higher than that of ST (33.4%, daf) at 320°C, 30min and 20% TS in the same reactor. WW had a similar carbon and hydrogen distribution in the four product fractions under HTL conditions compared with ST. 43.4% and 32.4% of carbon in WW11 and ST11 were released into the biocrude and aqueous phase in 500mL reactor, respectively. As much as 64.5% of the hydrogen was transferred to the aqueous phase. GC–MS results showed that the chemical compounds in the biocrude oil from WW consist of a variety of chemical constituents, such as hydrocarbons, acids, alcohols, ketones, phenols and aldehydes. These two biocrude oils contained 17.5% wt. and 8.64% wt. hydrocarbons, and 63.7% wt. and 79.8% wt. oxygen-containing compounds, respectively. TGA results showed that 69.3%–66.7% of the biocrude oil was gasified in 30°C–400°C. This study demonstrates the great potential for biocrude oil production from microalgae grown in biogas effluent via HTL.

Graphical abstract



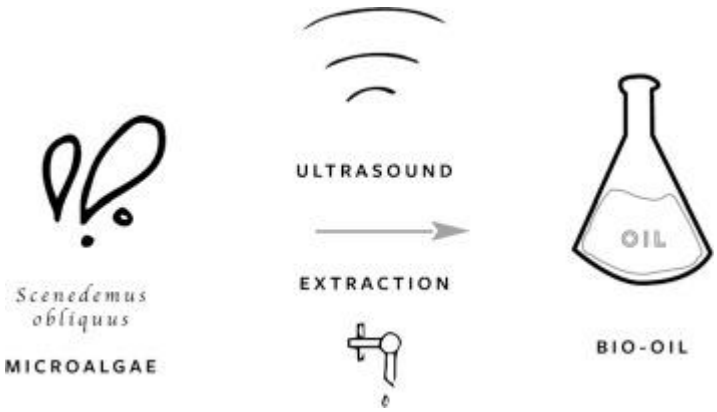
Application of central composite design in the optimization of lipid yield from Scenedesmus obliquus microalgae by ultrasound-assisted solvent extraction

Fecha: 15 Agosto 2018
Fuente: Energy, Volume 157
Autores: Alexander L. Ido, Mark Daniel G. de Luna, Sergio C. Capareda, Amado L. Maglinao, Hyungseok Nam

Abstract

The production of carbon-neutral, renewable, and environment-friendly biofuels is currently being implemented worldwide to mitigate the excessive use of petroleum-based fuels. Fast-growing lipid-producing microalgae, such as Scenedesmus obliquus, are considered ideal feedstocks for biofuel production. In this study, the separation of lipids from Scenedesmus obliquus microalgae was done through ultrasound-assisted solvent extraction (UASE) process using various solvent mixtures. The effects of resonance amplitude, n-hexane and isopropanol (HIP) ratio, and reaction time on lipid yield were evaluated. Lipid yield optimization was done through central composite design (CCD) of the response surface methodology (RSM). Lipid yield of 26.63% was obtained at 50 µm resonance amplitude and 4 v/v HIP ratio. The extracted lipids, mainly composed of fatty acids and esters, had a high heating value (HHV) of 35.38 MJ kg^{-1}. Overall, the results of the study validate the effectiveness of the UASE process for microalgal lipid extraction.

Graphical abstract



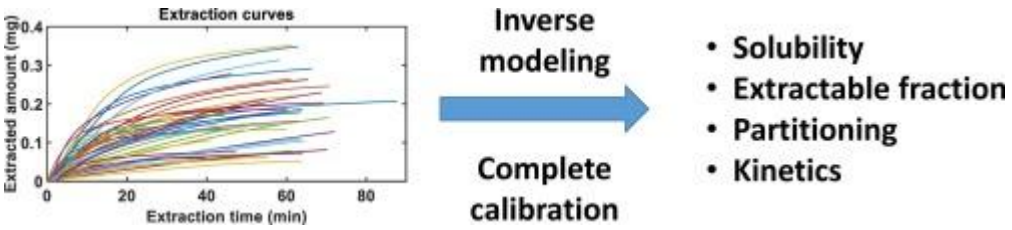
Multicomponent inverse modeling of supercritical fluid extraction of carotenoids, chlorophyll A, ergosterol and lipids from microalgae

Fecha: Septiembre 2018
Fuente: The Journal of Supercritical Fluids, Volume 139
Autores: Victor Abrahamsson, Larissa P. Cunico, Niklas Andersson, Bernt Nilsson, Charlotta Turner

Abstract

The fundamentals of analyte extractable fraction, solubility, partitioning and mass transfer resistance in supercritical fluid extraction were studied using inverse modeling. These phenomena are essential for understanding, predicting and optimizing the supercritical fluid extraction process. Carotenoids, chlorophyll A, ergosterol and total lipids were extracted from the microalgae Chlorella sp. The analytes were measured continuously in-line and on-line using UV/Vis absorption spectroscopy measurements and by evaporative light scattering detection. Various pressures, temperatures, flow rates and fractions of ethanol as a co-solvent were evaluated. The extractable fraction of carotenoids, chlorophyll A and total lipids were dependent on the co-solvent fraction in the extraction phase. The additional amount that could be extracted by using more co-solvent followed a normal distribution, indicating that analytes should not simply be categorized into weakly or strongly bound. The characteristics of diminishing extraction rates over time was accounted for by analyte partitioning rather than intra-particle diffusion limitations.

Graphical abstract



Nutrients recycling and energy evaluation in a closed microalgal biofuel production system

Fecha: Julio 2018
Fuente: Algal Research, Volume 33
Autores: Libin Yang, Xiaobo Tan, Buchun Si, Fangchao Zhao, Huaqiang Chu, Xuefei Zhou, Yalei Zhang

Abstract

A closed process for microalgal biofuel production involving in lipid extraction, anaerobic

digestion, and microalgal cultivation was proposed. Nutrients recycling and energy in the system were evaluated. During the anaerobic digestion process, 69.37% of nitrogen and 60.22% of phosphorus resided in the lipid-extracted microalgae (LEM) were released into the digested liquid (DL). Microalgae (Chlorella pyrenoidosa) could grow normally in mixed 10% DL and Selenite Enrichment (SE) medium (without nitrogen and phosphorus additives). The maximum biomass concentration was 1.25 g/L (dry biomass), which was higher than that obtained with the standard SE medium (1.18 g/L dry biomass). This indicates that the abundant nutrients in the DL can be recycled for more sustainable microalgae growth. Economic analysis evaluated that recycling of nutrients in the DL could potentially reduce nutrient cost by 41.77%. Additionally, 28.38% more energy was recovered as methane in LEM during the anaerobic digestion process. This would compensate for the cost of microalgae biofuel production.

Fate and reuse of nitrogen-containing organics from the hydrothermal conversion of algal biomass

Fecha: Junio 2018
Fuente: Algal Research, Volume 32
Autores: Mariluz Bagnoud-Velásquez, Eya Damergi, Gaël Peng, Frédéric Vogel, Christian Ludwig

Abstract

Hydrothermal (HT) conversion is a promising and suitable technology for the generation of biofuels from microalgae. Besides the fact that water is used as a “green” reactant and solvent and that no biomass drying is required, the technology offers a potential nutrient source for microalgae culture using an aqueous effluent very rich in essential inorganic nutrients. However, upon continuous and multiple recycling of this HT effluent, the recalcitrant organic fraction is likely to increase and may potentially attain toxic thresholds for microalgae use. In this work, we show the presence of recalcitrant N-containing organic compounds (NOC's) in the HT effluent. The most prominent NOC's in the extracts were carefully examined for their effect on microalgae, namely 2-pyrrolidinone and β-phenylethylamine (β-PEA). The first set of experiments consisted in testing these two substances at three different concentrations (10, 50 and 150 ppm) using three different microalgae strains: Phaeodactylum tricornutum, Chlorella sorokiniana and Scenedesmus vacuolatus. The confirmed half maximal inhibitory concentration (IC50) was approximately 75 ppm for all tested species. In the second set of experiments, P. tricornutum was grown using diluted HT effluent. Experimental conditions were set by adjusting the nitrogen concentration in the HT effluent to be equal to a known commercial medium. The concentrations of specific NOC's were lowered to concentrations of 8.5 mg/L 2-pyrrolidinone and 0.5 mg/L β-PEA after dilution. The growth of P. tricornutum using the diluted HT solution was kept constant with no evidence of inhibition or consumption of NOC's, as the concentration of the specific compounds remains the same before and after growth. Therefore, in order to avoid effects of accumulation of NOC's upon continuous recycling, the HT effluent was pumped through the existing hydrothermal gasification unit as a water clean-up step. The conversion of NOC's to ammonium was successfully achieved.

Improving cell disruption efficiency to facilitate protein release from microalgae using chemical and mechanical integrated method

Fecha: 15 Julio 2018
Fuente: Biochemical Engineering Journal, Volume 135
Autores: Win Nee Phong, Pau Loke Show, Cheng Foh Le, Yang Tao, Jo-Shu Chang, Tau Chuan Ling

Abstract

One of the critical challenges in releasing protein from microalgae is to effectively disrupt their rigid thick cell walls. This study could provide some guidance on the implementation of a simple, cost-effective and scalable cell disruption in a downstream processing of microalgal industry for the recovery of protein from microalgae. The effects of solvent types, alkalis, and ultrasonication in disrupting microalgal cell wall and protein solubility were studied. It was found that alkaline treatment played a key role in cell disruption and protein solubilisation. From the industrial perspective, water is an excellent choice of extractive solvent due to low-cost, safety, and scalability. Among all the tested methods, the combination of both alkaline and ultrasonication treatment demonstrated the greatest cell disruption efficiency and was thus suggested to be use at large scale.

Optimization of phycocyanin extraction from Spirulina platensis using different techniques

Fecha: Julio 2018
Fuente: Journal of Food Composition and Analysis, Volume 70
Autores: Işıl İlter, Saniye Akyıl, Zeliha Demirel, Mehmet Koç, Meltem Conk-Dalay, Figen Kaymak-Ertekin

Abstract

Phycocyanin is an important commercially available blue food colorant. Herein we report an optimization study of various phycocyanin extraction methods from Spirulina platensis cyanobacterium biomass (dry, frozen and wet). Three different solvents i.e. distilled water, Na-Phosphate pH: 7.4 suspension and 1.5% CaCl2 (w/v) water solution were applied as the extraction medium. The highest total phycocyanin content (55.33 mg/g) was extracted from frozen biomass using 1.5% CaCl2 (w/v aq.) solution. Process variables of classical, ultrasound and microwave extraction methods (biomass/solvent ratio, extraction time, vibration, speed, and power) were optimized considering the CCRD experimental design to enrich phycocyanin. The optimum conditions of extraction methods; classical, ultrasound and microwave were determined as: 1.71% biomass/solvent ratio, 6237.66 homogenization rate and 15 min extraction time; 1% biomass/solvent ratio, 60% amplitude and 16.23 min extraction time; 2.34% biomass/solvent

ratio, 133.29 W and 165.96 s extraction time. Classical extraction method provided vivid blue color, a higher amount of phycocyanin, and maximum antioxidant activity as compared to other extraction methods.

An integrated biorefinery process: Stepwise extraction of fucoxanthin, eicosapentaenoic acid and chrysolaminarin from the same Phaeodactylum tricornutum biomass

Fecha: Junio 2018
Fuente: Algal Research, Volume 32
Autores: Wenyuan Zhang, Feifei Wang, Baoyan Gao, Luodong Huang, Chengwu Zhang

Abstract

The cultivation of microalgae is a high energy consumption process, which consumes a large amount of water, nutrients, electric energy and manpower. Thus, comprehensive utilization of algal biomass is a key to achieving cost-effective industrial production of bioproducts. In this paper, an integrated biorefinery process was conducted on Phaeodactylum tricornutum biomass to produce three valuable bioactive compounds via stepwise extraction using different solvent systems. Fucoxanthin, highly concentrated eicosapentaenoic acid (EPA), and chrysolaminarin were successively purified, concentrated, and characterized from P. tricornutum with a series of separation and identification technologies, and the yield (the weight of the purified compounds/the absolute weight in algal biomass, %) of these active compounds were 34.03 ± 0.72%, 23.00 ± 0.29%, and 43.54 ± 0.91%, respectively. Moreover, the fucoxanthin extraction conditions were also optimized, and ethanol and microwave-assisted treatments of 1 min provided the best fucoxanthin yield. In conclusion, this study suggested an effective biorefinery process for the production of fucoxanthin, EPA, and chrysolaminarin from the same P. tricornutum biomass.

Graphical abstract

PATENTES

Method for sorting chlorella cells

Inventor(s): YU JIANZHONG; XUE MINGXIONG + (俞建中, ; 薛命雄)

Applicant(s): BEIHAI SBD BIO SCIENCE & TECH CO LTD + (北海生巴达生物科技有限公司)

Abstract of CN106119119 (A)

The invention relates to the technical field of microalgae culture and in particular relates to a method for sorting chlorella cells. The method comprises the following steps: (1) filtering and removing impurities; (2) judging a state of algae solution; and (3) sorting. Due to cell sorting, mature cells with superior indexes such as proteins, chlorophyll and the like are harvested, while immature cells flow back to be further cultured, so that the superiority and stability of the product quality are improved; and lots of immature cells return to culture, so that the batch culture period can be shortened. According to the method, primary concentration of the algae solution can be realized, the energy consumption in the harvesting process can be greatly reduced, and the effects of shortening the needed time for harvesting of yield per unit and wholly reducing the harvesting cost are achieved.

Method of extracting microalgae fat

Inventor(s): LI XIAOSHU; GAO DACHENG; SHI WENJING; LIAO SHA; SUN QIMEI; WANG PENGXIANG + (李晓姝, ; 高大成, ; 师文静, ; 廖莎, ; 孙启梅, ; 王鹏翔)

Applicant(s): CHINA PETROLEUM & CHEM CORP; SINOPEC FUSHUN RES INST PET + (中国石油化工股份有限公司, ; 中国石油化工股份有限公司抚顺石油化工研究院)

Abstract of CN106554845 (A)

The invention discloses a method of extracting microalgae fat, which includes the following steps: (1) adding certain amounts of an inorganic salt solution and an alkaline solution to collected microalgae, uniformly mixing the components, and performing radiation heating in a microwave generator, so that cell walls are dissolved and ruptured by means of cooperative effects of alkali, salt and microwave; (2) continuously performing a saponification reaction to alkali and fatty acid esters released from the cells to generate fatty acid salts; (3) filtering the liquid to remove microalgae cell debris; (4) continuously adding the inorganic salt solution to the reaction system to separate the fatty acid salt solution out, and filtering the liquid to collect a solid; and (5) adding inorganic acid to the fatty acid salts to acidify the fatty acid salts to obtain free fatty acid, and collecting the fatty acid product. In the invention, the microalgae fat is extracted through a water-phase method, so that the method is simple in operation process, is high in yield of the microalgae fat and is environment-friendly.

Application of bio-membrane reactor in sewage treatment, carbon sequestration microalgae harvesting

Inventor(s): WU XIAODAN; LIU YUHUAN; ZHU RONGBI; ZHENG HONGLI; LUO SHANSHAN; WANG YUNPU; XIANG SHUYU; YAN CHI + (巫小丹, ; 刘玉环, ; 朱榕璧, ; 郑洪立, ; 罗珊珊, ; 王允圃, ; 向书玉, ; 严持)

Applicant(s): UNIV NANCHANG + (南昌大学)

Abstract of CN107012072 (A)

The invention discloses application of a bio-membrane reactor in sewage treatment, carbon sequestration microalgae harvesting. The bio-membrane reactor comprises a photo-biological reaction system, a gas allocation system and a column-shaped dissolved-gas-gas floating harvesting system. By adopting the reactor, deep sewage purification can be achieved by using microalgae. A vertical space can be very well utilized by using a vertically suspended membrane material; by adopting a membrane component, the gas-liquid transfer efficiency is greatly improved; due to a special arrangement mode of a curtain type membrane component, scattering loss of light can be reduced to the maximum extent, energy loss is avoided, efficient absorption and utilization of the microalgae on a luminous energy envelope are ensured, and the algae cell lighting homogeneity is achieved; low-cost green harvesting of the microalgae on membranes is achieved through simple mechanical scraping. Low-cost green gas dissolution-gas floating harvesting of the suspended microalgae is achieved through the column-shaped dissolved-gas-gas floating harvesting system, meanwhile CO2 dissolved gases are functionally concentrated in a harvesting device, and CO2 enriched microalgae culture is achieved through the gas allocation system and the column-shaped dissolved-gas-gas floating harvesting system in the culture process.

OZONE FLOTATION FOAM REACTOR FOR MICROALGAE SEPARATION FOR BIOFUEL PRODUCTION.

Inventor(s): MARÍA TERESA ORTA LEDESMA [MX]; VERÓNICA RODRÍGUEZ MUÑIZ; IGNACIO MONJE RAMÍREZ; SHARON BELINDA VELASQUEZ ORTA + (María Teresa ORTA LEDESMA, ; Verónica RODRÍGUEZ MUÑIZ, ; Ignacio MONJE RAMÍREZ, ; Sharon Belinda VELASQUEZ ORTA)

Applicant(s): UNIV NAC AUTÓNOMA DE MÉXICO [MX] + (UNIVERSIDAD NACIONAL AUTÓNOMA DE MÉXICO)

Abstract of MX2015016929 (A)

The present disclosure is related to an ozone flotation foam reactor to harvest microalgal biomass by the ozone flotation process, comprising: the body of a column, a manifold located at the top of the column, a porous diffuser, an inlet and an outlet.

Photobioreactor and method for synchronously realizing microalgae immobilized culture and sewage treatment

Inventor(s): GAO FENG; LI CHEN; LIU DUNZHI; CUI WEI + (高锋, ; 李晨, ; 刘俊稚, ; 崔伟)

Abstract of CN106064853 (A)

The invention discloses a photobioreactor for synchronously realizing microalgae immobilized culture and sewage treatment. The photobioreactor comprises a transparent reactor, a separator plate group, a microalgae harvest system and an aeration system. The separator plate group is fixed in the reactor and divides the inner space of the reactor into a main reaction zone and a water outlet zone. A biomembrane filling material is arranged in the main reaction zone. The biomembrane filling material is connected to the microalgae harvest system fixed to the upper part of the reactor. The water outlet zone is provided with an ultrafilter membrane filtering unit.

The aeration system is fixed to the bottom of the reactor. The photobioreactor has a simple structure, can be operated simply and conveniently, synchronously realizes sewage treatment and microalgae production, realizes high efficiency microalgae separation and harvest, realizes complete interception of microalgae in outlet water and provides a novel approach for sewage treatment. The invention also provides a method for synchronously realizing microalgae immobilized culture and sewage treatment. The method has simple processes, good operationality, a low operation cost and good continuity.

Microwave-assisted green solvent wet-process oil extraction method for microalgae

Inventor(s): YANG QIAOLI; ZHU ZHENQI; XU CHUNBAO; DU YANSHAN + (YANG QIAOLI, ; ZHU ZHENQI, ; XU CHUNBAO, ; DU YANSHAN)

Applicant(s): ENN RES & DEV CO LTD + (ENN RESEARCH AND DEVELOPMENT CO., LTD)

Abstract of CN102994220 (A)

The invention discloses a wet-process oil extraction method for microalgae, comprising the steps of adding a medium-polarity solvent in microalgae mud, and performing microwave heating extraction. Wall breakage and oil extraction for microalgae are performed simultaneously in the method, the process is simple and easy to operate, and the oil of wet microalgae can be rapidly extracted in one step, thus facilitating realizing industrialization; the method is suitable for oil extraction for the algae produced by autotrophic cultivation and heterotrophic cultivation, capable of achieving a high oil extraction rate, and free from the limits of cultivation methods; the obtained oil is good in quality and beneficial to maintaining the high-added-value active ingredients of microalgae; and a slightly-toxic or lowly-toxic organic solvent with an oil-dissolving capacity is used for extraction and harmless to environment, wherein in particular, isopropanol is an extraction solvent for vegetable oil which is recommended by FDA (Food and Drug Administration), and capable of being used for extracting and processing the high-nutrition oil of microalgae.

Airlift loop bioreactor through microalgae photoautotrophic-photoheterotrophic coupling for carbon emission reduction in sewage treatment

Inventor(s): XIAO CHEN; JINPENG LI; HONGYANG SU; CHUNMIN ZHANG; YALEI ZHANG; XUEFEI ZHOU + (CHEN XIAO, ; LI JINPENG, ; SU HONGYANG, ; ZHANG CHUNMIN, ; ZHANG YALEI, ; ZHOU XUEFEI)

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

Abstract of CN101838606 (A)

The invention belongs to the technical field of sewage treatment, in particular to an airlift loop bioreactor through microalgae photoautotrophic-photoheterotrophic coupling for carbon emission reduction in sewage treatment, which comprises an inlet pipe, a microalgae heterotrophic zone, a gas-liquid separation chamber, a microalgae photoautotrophic zone, a bottom reflow zone, a vent pipe and a liquid outlet zone. The invention adopts the way of separating a carbon dioxide supply device from an air lift device to improve the mass transfer and utilization ratio of carbon dioxide through flat ultra-filtration membrane distribution; the air lift device just meets the demand of microalgae lift and flow circulation; through microalgae photoautotrophic-photoheterotrophic coupling, and by taking advantage of the microalgae which use different carbon sources, the problem of difficult oxygen release in closed pipe photobioreactor is solved, so as to reduce the inhibiting effect of dissolved oxygen, enhance lateral mixing of microalgae liquid in the photoautotrophic zone, and reduce the negative influence caused by mutual shade of cells; therefore, natural sunlight can be fully utilized to decrease the culture cost and obviously increase illumination utilization ratio of the photobioreactor. The invention has the advantage of high efficiency of carbon fixation, high concentration of microalgae culture, stale system operation, easy enlargement of reactor, simple process, convenient operation, low cost of running and maintenance and the like, suitable for carbon emission reduction in sewage treatment and high-efficient culture of microalgae with large scale and low cost.

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 processing feed through waste water microalgae

Inventor(s): LIU XUE; SHENG QINGKAI; GENG BING; ZHU CHANGXIONG; SUN LIQIN; SUN ZHONGLIANG; WANG XINGLING + (LIU XUE, ; SHENG QINGKAI, ; GENG BING, ; ZHU CHANGXIONG, ; SUN LIQIN, ; SUN ZHONGLIANG, ; WANG XINGLING, ; 刘雪, ; 盛清凯, ; 耿兵, ; 朱昌雄, ; 孙利芹, ; 孙中亮, ; 王星凌)

Applicant(s): INST ENVIRONMENT & SUSTAINABLE DEV IN AGRICULTURE; SHENG QINGKAI + (INSTITUTE OF ENVIRONMENT AND SUSTAINABLE DEVELOPMENT IN AGRICULTURE, CHINESE ACADEMY OF AGRICULTURAL SCIENCES, ; SHENG QINGKAI, ; 中国农业科学院农业环境与可持续发展研究所, ; 盛清凯)

Abstract of CN104982731 (A)

The invention discloses a method for processing feed through waste water microalgae. According to the method, the microalgae cultured, collected and deposited through waste water is mixed with cornhusk and bacillus subtilis, then the mixture is accumulated on the ground and subjected to aerobic fermentation, and high temperature generated in the fermentation process is fully used for killing bacteria; cooled microalgae materials obtained after aerobic fermentation are mixed with pig overhead price compound feed, lactobacillus plantarum and trichoderma longibrachiatum are added in the mixing process, the moisture content is adjusted to be 40-50%, and the feed is taken out and fed to pigs after the feed is subjected to anaerobic fermentation and the pH is 3.5-5.0. By means of the method, the utilization rate of waste water is increased, drying cost of the microalgae is reduced, pathogenic bacteria in the waste water are killed, bio-security of microalgae utilization is improved, and feed-based utilization of the microalgae is promoted. The feed processed through the waste water microalgae is high in probiotic content, and productivity of the pigs is increased.

Microalgae large-scale harvesting method

Inventor(s): ZHANG LI; ZHAO KUI; LI RUNZHI + (张莉, ; 赵奎, ; 李润植)

Applicant(s): ZHANG LI; ZHAO KUI; LI RUNZHI + (张莉, ; 赵奎, ; 李润植)

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.

EVENTOS

May 15-16 US Microalgae Industry Summit
Fort Lauderdale, Florida
The event will bring together senior executives and experts from the algae industry, consultants, technology innovators and leading market analysts to discuss the latest challenges and developments within the industry.
More Info

May 21-22 Algae Bloom Remediation Workshop
Broward County Library Downtown, Ft. Lauderdale, Florida
The National Algae Association has invited commercially-minded algae bloom researchers, remediation technology and equipment companies to discuss differences between algae blooms created by phosphorous and nitrogen vs. toxic hazardous algae blooms (HAB's) and educate attendees about potential algae bloom remediation…
More Info
EABA Novel Food for Algae Biomass Workshop | 22-23 May 2019
EABA Standardization of Algae Biomass Workshop | 23-24 May 2019

May 27-30 European Biomass Conference and Exhibition
Lisbon Congress Center, Lisbon, Portugal
The EUBCE combines one of the largest biomass science and technology conferences with a high quality industry exhibition, attracting biomass professionals from around the world.
More Info

June 5-6 Oleofuels
Venice, Italy
…will bring together senior representatives from the biodiesel, renewable diesel and HVO industries to discuss the latest market advancements, developments & business opportunities.
More Info

June 17-19 International Conference on Algal Biomass, Biofuels and Bioproducts.
Embassy Suites, Boulder, CO, USA
AlgalBBB places a major emphasis on the latest unpublished technical and scientific results, along with discussion and direct interactions with strategic partners, funding sponsors, and leaders in the field.
More Info
EABA Nannochloropsis Workshop | 18-19 June 2019
9th Symposium on "Microalgae and Seaweed Products in Plant/Soil-Systems" | 25-26 June 2019
EABA Algae Based Biofuels Workshop | 17-18 July 2019

July 15-18 Artisan Spirulina Immersion Workshops 2019
Santa Fe Community College, 6401 Richards Avenue, Santa Fe, New Mexico
In this comprehensive four-day workshop students will get three days of hands on Artisan Spirulina farming, learning the French cultivation method. Workshops are capped at 6 students.
More Info

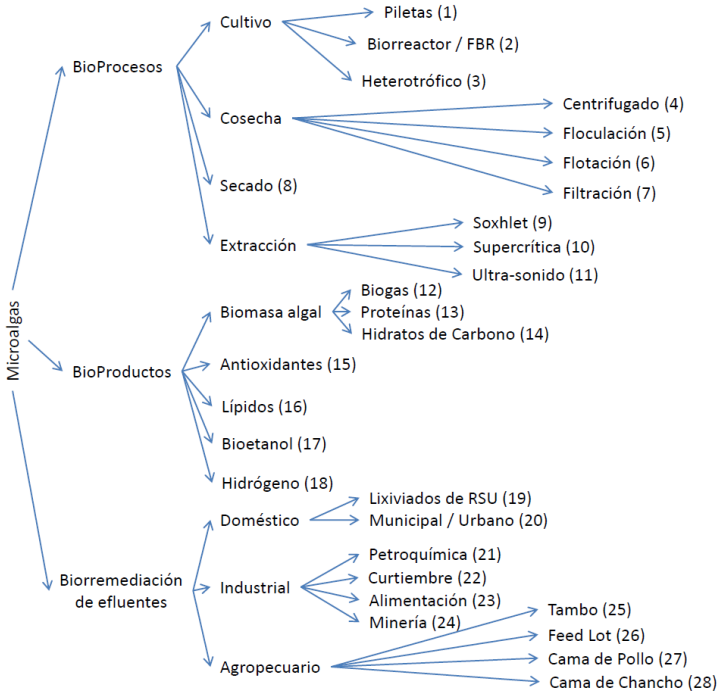
August 26-29 Artisan Spirulina Immersion Workshops 2019
Santa Fe Community College, 6401 Richards Avenue, Santa Fe, New Mexico
In this comprehensive four-day workshop students will get three days of hands on Artisan Spirulina farming, learning the French cultivation method. Workshops are capped at 6 students.
More Info

Algae Tech Conference
4-5 September 2019
Madrid, Spain

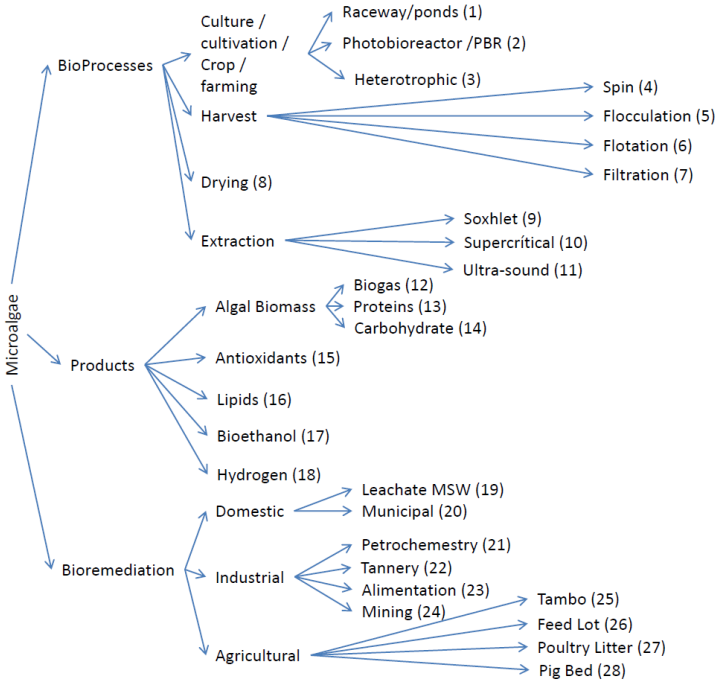
XII Simposio Argentino de Ficología
11 y 12 de septiembre de 2019
Facultad de Ciencias Exactas y Naturales. Universidad de Buenos Aires.
CABA-Argentina
http://www.fundacen.org.ar/saf2019_ar/

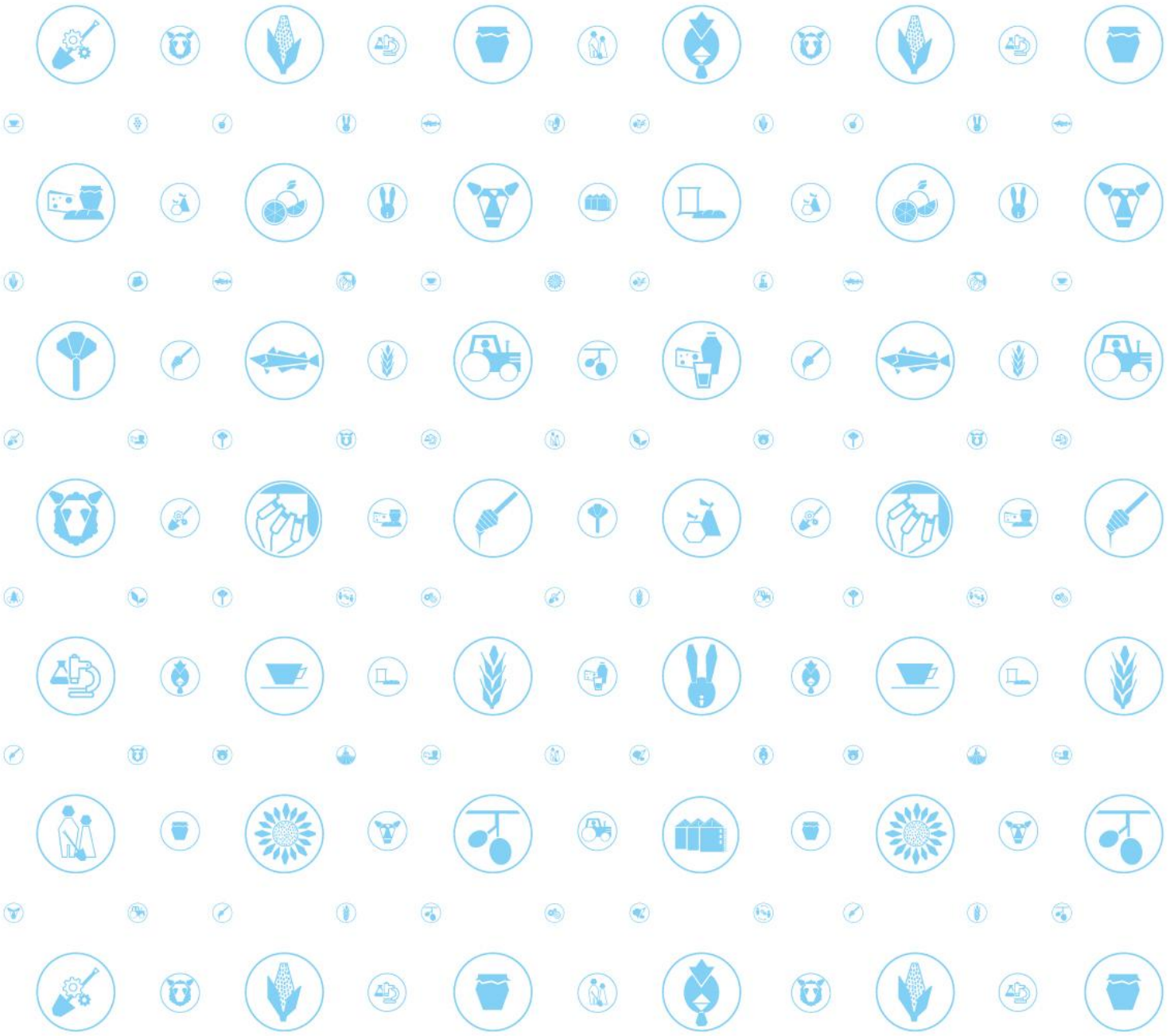
September 16-19 Algae Biomass Summit
Rosen Centre Hotel, Orlando, Florida
This marks the 13th annual staging of the world's largest algae conference and trade show, and its first return to Florida since 2013.
More Info
Seagriculture 2019 | 25-26 September 2019
Seagriculture 2019 | 25-26 September 2019
Seagriculture 2019 | 25-26 September 2019

Árbol de categorías
Español



Inglés





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