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Contenido

PUBLICACIONES

A New Species of Freshwater Algae Nephrochlamys yushanlensis sp. nov. (Selenastraceae, Sphaeropleales) and Its Lipid Accumulation during Nitrogen and Phosphorus Starvation

Autor: Yevhen Maltsev

J Phycol. 2021 Apr;57(2):606-618. doi: 10.1111/jpy.13116. Epub 2021 Jan 28.

ABSTRACT

The new species Nephrochlamys yushanlensis sp. nov. is described from a freshwater plankton sample. A comparison of morphology, 18S rDNA gene and ITS2 sequences, and fatty acid profiles showed that the novel strain represents a new lineage within the genus Nephrochlamys. For the first time with a member of the Selenastraceae, experiments with phosphate and nitrate deprivation were conducted to evaluate changes in biomass, lipid and triacylglycerol (TAGs) accumulation, and composition of fatty acids. Biomass dry weight under simultaneous nitrogen and phosphorus depletion was 1.73 g · L-1 , which is significantly lower than the 2.41 g · L-1 observed in the control. All conditions of nutrient restriction significantly increased the lipid content in comparison with the control. The largest increase in the total lipid content, reaching 58.64% DW per cell at the end of cultivation, occurred with nitrogen deficiency. Significant increases in TAGs content (to 23.69% and 21.74%, respectively) occurred in phosphorus- and nitrogen-depleted conditions in comparison to the control (16.90%). Oleic (49.8-64.1%), palmitic (21.1-22.7%), and linoleic (8.6-10.3%) acids were the dominant fatty acids when cultured on standard BBM medium, as well as with the shortage of nutrients. Phosphorus deprivation as well as absence of both nitrogen and phosphorus led to the appearance of FAMEs α-linolenic (1.5-4.1%) and stearidonic (1.0-1.8%) acids. In general, FAME profiles revealed that the relative percentage of saturated and monounsaturated fatty acids increased (88.9% of total fatty acids) in nitrogen-depletion conditions, suggesting this strain may be suitable for biodiesel production.

A sustainable approach by using microalgae to minimize the eutrophication process of Mar Menor lagoon

Autor: A Gil-Izquierdo

Sci Total Environ. 2021 Mar 1;758:143613. doi: 10.1016/j.scitotenv.2020.143613. Epub 2020 Nov 11.

ABSTRACT

The present study evaluates the removal capacity of microalgae photobioreactors of environmental pollutants present in wastewater from the dry riverbed El Albujón, as a way to minimize the eutrophication process of the Mar Menor. Particularly, the capacity of four autochthonous microalgae consortia collected from different locations of the salty lagoon to remove emerging contaminants (simazine, atrazine, terbuthylazine, adenosine and ibuprofen), nitrates, and phosphates, was evaluated. Among the four microalgae consortia, consortium 1 was the best in terms of biomass productivity (0.11 g L-1 d-1) and specific growth rate (0.14 d-1), providing 100% removal of emerging contaminants (simazine, atrazine, terbuthylazine, adenosine and ibuprofen), and a maximal reduction and consumption of macronutrients, especially nitrates and phosphates, reaching levels below 28 mg L-1, that is, a decrease of 89.90 and 99.70% of nitrates and phosphates, respectively. Therefore, this consortium (Monoraphidium sp., Desmodesmus subspicatus, Nannochloris sp.) could be selected as a green filter for successful large-scale applications. This study is the first one that combines the successful removal of herbicides, ibuprofen and adenosine as emerging contaminants, and nitrate removal.

Adaptation to Aquatic and Terrestrial Environments in Chlorella vulgaris (Chlorophyta)

Autor: Siegfried Aigner

Front Microbiol. 2020 Oct 15;11:585836. doi: 10.3389/fmicb.2020.585836. eCollection 2020.

ABSTRACT

The globally distributed green microalga Chlorella vulgaris (Chlorophyta) colonizes aquatic and terrestrial habitats, but the molecular mechanisms underpinning survival in these two contrasting environments are far from understood. Here, we compared the authentic strain of C. vulgaris from an aquatic habitat with a strain from a terrestrial high alpine habitat previously determined as Chlorella mirabilis. Molecular phylogeny of SSU rDNA (823 bp) showed that the two strains differed by one nucleotide only. Sequencing of the ITS2 region confirmed that both strains belong to the same species, but to distinct ribotypes. Therefore, the terrestrial strain was re-assessed as C. vulgaris. To study the response to environmental conditions experienced on land, we assessed the effects of irradiance and temperature on growth, of temperature on photosynthesis and respiration, and of desiccation and rehydration on photosynthetic performance. In contrast to the aquatic strain, the terrestrial strain tolerated higher temperatures and light conditions, had a higher photosynthesis-to-respiration ratio at 25°C, still grew at 30°C and was able to fully recover photosynthetic performance after desiccation at 84% relative humidity. The two strains differed most in their response to the dehydration/rehydration treatment, which was further investigated by untargeted GC-MS-based metabolite profiling to gain insights into metabolic traits differentiating the two strains. The two strains differed in their allocation of carbon and nitrogen into their primary metabolites. Overall, the terrestrial strain had higher contents of readily available nitrogen-based metabolites, especially amino acids and the polyamine putrescine. Dehydration and rehydration led to differential regulation of the amino acid metabolism, the tricarboxylic acid cycle and sucrose metabolism. The data are

discussed with a view to differences in phenotypic plasticity of the two strains, and we suggest that the two genetically almost identical C. vulgaris strains are attractive models to study mechanisms that protect from abiotic stress factors, which are more frequent in terrestrial than aquatic habitats, such as desiccation and irradiation.

Allelopathic inhibitory effect of the macroalga Pyropia haitanensis (Rhodophyta) on harmful bloom-forming Pseudo-nitzschia species

Autor: Vishal Patil

Mar Pollut Bull. 2020 Dec;161(Pt A):111752. doi: 10.1016/j.marpolbul.2020.111752. Epub 2020 Oct 19.

ABSTRACT

The blooms of harmful microalgae represent a prominent threat to fisheries, public health, and economies throughout the world. Recent studies have shown that certain macroalgae release allelochemicals that can inhibit the growth of bloom-forming microalgae. In this study, we found that the macroalga Pyropia haitanensis significantly inhibited growth of the harmful bloom-forming microalgae Pseudo-nitzschia pungens and Pseudo-nitzschia multiseries. The inhibitory-effect of the live thali of P. haitanensis was highest, followed by that of dry powder, water-soluble extract, and culture medium filtrate. The Pseudo-nitzschia species died 96 h after exposure to 5-10 g fresh-weight L-1 of P. haitanensis live thalli. Furthermore, an aqueous extract of P. haitanensis suppressed the growth of P. pungens and P. multiseries, thereby indicating that P. haitanensis contains stable allelopathic substances that cause the observed inhibitory-effects. On the basis of these findings, we conclude that the macroalga P. haitanensis would have potential utility in controlling the blooms of Pseudo-nitzschia species.

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

Autor: Tethi Biswas

J Environ Manage. 2021 Feb 25;286:112196. doi: 10.1016/j.jenvman.2021.112196. Online ahead of print.

ABSTRACT

The present study attempts to integrate phyco-remediation and enhanced lipid productivity using microalgae-bacterial consortium enriched from wastewater fed aquaculture pond. Metagenomic analyses and microscopic images of the consortium revealed the presence of Chlorella variabilis, Parachlorella kessleri, Thermosynechococcus elongatus, Chlamydomonas, Phaeodactylum tricornutum, Oscillatoriales, Synechocystis sp., Microcystis aeruginosa, Nostocales, Naviculales, Stramenopiles, other members of Chlorophyceae, Trebouxiophyceae, and Chroococcales along with potential bacterial bioremediants. During a 30 days trial run (15

days stabilization and 14 days remediation studies) for phyco-remediation drastic reduction in the nutrient and COD content from the tested wastewater samples was seen. There was up to 93% and 87.2% reduction in chemical oxygen demand (COD) and ammonium concentration, respectively. Further, almost 100% removal of nitrates and phosphates from the dairy wastewater upon 48 h of treatment with polyculture under ambient temperature (25 ± 2 °C) with 6309 lux illumination and mild aeration, was observed for all the seven cycles. Interestingly, the nutrient and COD concentrations in the treated water were below the discharge standards as per Central Pollution Control Board (CPCB) norms. In additions, biomass (reported as dry cell weight) was enhanced by 67% upon treatment with ammonia-rich dairy wastewater exhibiting 42% lipid, 55% carbohydrate, and 18.6% protein content enhancement. The polyculture mainly grown as attached biofilm to the surface, offered an easy harvesting and separation of grown biomass from the treated wastewater. Overall, dairy wastewater was found to be a potential nutrient source for microalgae-bacteria cultivation thereby making the treatment process sustainable and eco-friendly.

Annual cycle of mat-forming filamentous alga Tribonema cf. minus (Stramenopiles, Xanthophyceae) in hydro-terrestrial habitats in the high Arctic revealed by multiparameter fluorescent staining

Autor: Matouš Jimel

J Phycol. 2020 Nov 27. doi: 10.1111/jpy.13109. Online ahead of print.

ABSTRACT

The filamentous microalga Tribonema sp. (Stramenopiles, Xanthophyceae) plays an important role in shallow water polar (streams and seepages) and seasonally cold habitats in temperate regions (ponds). In these habitats, freezing and desiccation, and thus freeze-thawing and drying-rewetting cycles, are frequent. These regions produce visible biomass and are important components of low temperature-adapted communities. We characterized the annual cycles of a Tribonema cf. minus population in two habitats (seepage and stream) in the High Arctic, Svalbard. Seasonality, locality and their combination (particularly changing environmental conditions) together with cultivation conditions of strains significantly affected their morphological characteristics. Morphological changes following hardening processes related to preparation for the winter period (transition from vegetative cells to akinete and/or pre-akinete) were recorded. Over the year, positive water temperatures (warmest 13.3°C) occurred for 5 months while negative (lowest temperature was - 17.4°C) lasted for 7 months. In winter, there were two melt periods. Vitality staining protocol showed a high number of viable (77.4 and 53.8%) and dormant cells (1.7 and 4.1%; capable of growth and reproduction once suitable conditions return) in the winter seepage and stream, respectively. NPQ and OJIP chlorophyll fluorescence parameters revealed several hours recovery of photosynthesis (both field and control samples). During recovery, only minor or mild stress on photosynthesis was detected. FV /FM values (the photosynthetic efficiency of photosystem II in a dark-adapted state) in all field and control samples varied around 0.4. Tribonema cf. minus is capable of surviving winter Arctic conditions (perennial strategy).

Aquatic plants and ecotoxicological assessment in freshwater ecosystems: a review

Autor: Simona Ceschin

Environ Sci Pollut Res Int. 2021 Feb;28(5):4975-4988. doi: 10.1007/s11356-020-11496-3. Epub 2020 Nov 26.

ABSTRACT

This paper reviews the current state-of-the-art, limitations, critical issues, and new directions in freshwater plant ecotoxicology. We selected peer-reviewed studies using relevant databases and for each (1) publication year, (2) test plant species, (3) reference plant group (microalgae, macroalgae, bryophytes, pteridophytes, flowering plants), (4) toxicant tested (heavy metal, pharmaceutical product, hydrocarbon, pesticide, surfactant, plastic), (5) experiment site (laboratory, field), and (6) toxicant exposure duration. Although aquatic plant organisms play a key role in the functioning of freshwater ecosystems, mainly linked to their primary productivity, their use as biological models in ecotoxicological tests was limited if compared to animals. Also, toxicant effects on freshwater plants were scarcely investigated and limited to studies on microalgae (80%), or only to a certain number of recurrent species (Pseudokirchneriella subcapitata, Chlorella vulgaris, Lemna minor, Myriophyllum spicatum). The most widely tested toxicants on plants were heavy metals (74%), followed by pharmaceutical products and hydrocarbons (7%), while the most commonly utilized endpoints in tests were plant growth inhibition, variations in dry or fresh weight, morpho-structural alterations, chlorosis, and/or necrosis. The main critical issues emerged from plant-based ecotoxicological tests were the narrow range of species and endpoints considered, the lack of environmental relevance, the excessively short exposure times, and the culture media potentially reacting with toxicants. Proposals to overcome these issues are discussed.

Biochemical and phylogenetic characterization of the wastewater tolerant Chlamydomonas biconvexa Embrapa|LBA40 strain cultivated in palm oil mill effluent

Autor: Patrícia Verdugo Pascoal

PLoS One. 2021 Apr 7;16(4):e0249089. doi: 10.1371/journal.pone.0249089. eCollection 2021.

ABSTRACT

The increasing demand for water, food and energy poses challenges for the world´s sustainability. Tropical palm oil is currently the major source of vegetable oil worldwide with a production that exceeds 55 million tons per year, while generating over 200 million tons of palm oil mill effluent (POME). It could potentially be used as a substrate for production of microalgal

biomass though. In this study, the microalgal strain Chlamydomonas biconvexa Embrapa|LBA40, originally isolated from a sugarcane vinasse stabilization pond, was selected among 17 strains tested for growth in POME retrieved from anaerobic ponds of a palm oil industrial plant located within the Amazon rainforest region. During cultivation in POME, C. biconvexa Embrapa|LBA40 biomass productivity reached 190.60 mgDW • L-1 • d-1 using 15L airlift flat plate photobioreactors. Carbohydrates comprised the major fraction of algal biomass (31.96%), while the lipidic fraction reached up to 11.3% of dry mass. Reductions of 99% in ammonium and nitrite, as well as 98% reduction in phosphate present in POME were detected after 5 days of algal cultivation. This suggests that the aerobic pond stage, usually used in palm oil industrial plants to reduce POME inorganic load, could be substituted by high rate photobioreactors, significantly reducing the time and area requirements for wastewater treatment. In addition, the complete mitochondrial genome of C. biconvexa Embrapa|LBA40 strain was sequenced, revealing a compact mitogenome, with 15.98 kb in size, a total of 14 genes, of which 9 are protein coding genes. Phylogenetic analysis confirmed the strain taxonomic status within the Chlamydomonas genus, opening up opportunities for future genetic modification and molecular breeding programs in these species.

Characterization and Biotechnological Potential of Intracellular Polyhydroxybutyrate by Stigeoclonium sp. B23 Using Cassava Peel as Carbon Source

Autor: Murilo Moraes Mourão

Polymers (Basel). 2021 Feb 25;13(5):687. doi: 10.3390/polym13050687.

ABSTRACT

The possibility of utilizing lignocellulosic agro-industrial waste products such as cassava peel hydrolysate (CPH) as carbon sources for polyhydroxybutyrate (PHB) biosynthesis and characterization by Amazonian microalga Stigeoclonium sp. B23. was investigated. Cassava peel was hydrolyzed to reducing sugars to obtain increased glucose content with 2.56 ± 0.07 mmol/L. Prior to obtaining PHB, Stigeoclonium sp. B23 was grown in BG-11 for characterization and Z8 media for evaluation of PHB nanoparticles' cytotoxicity in zebrafish embryos. As results, microalga produced the highest amount of dry weight of PHB with 12.16 ± 1.28 (%) in modified Z8 medium, and PHB nanoparticles exerted some toxicity on zebrafish embryos at concentrations of 6.25-100 µg/mL, increased mortality (<35%) and lethality indicators as lack of somite formation (<25%), non-detachment of tail, and lack of heartbeat (both <15%). Characterization of PHB by scanning electron microscopy (SEM), X-ray diffraction (XRD), differential scanning calorimeter (DSC), and thermogravimetry (TGA) analysis revealed the polymer obtained from CPH cultivation to be morphologically, thermally, physically, and biologically acceptable and promising for its use as a biomaterial and confirmed the structure of the polymer as PHB. The findings revealed that microalgal PHB from Stigeoclonium sp. B23 was a promising and biologically feasible new option with high commercial value, potential for biomaterial applications, and also suggested the use of cassava peel as an alternative renewable resource of carbon for PHB biosynthesis and the non-use of agro-industrial waste and dumping concerns.

Characterization of a novel strain of Tribonema minus demonstrating high biomass productivity in outdoor raceway ponds

Autor: Aubrey K Davis

Bioresour Technol. 2021 Jul;331:125007. doi: 10.1016/j.biortech.2021.125007. Epub 2021 Mar 18.

ABSTRACT

Photosynthetic algae represent a large, diverse bioresource potential. Yellow-green algae of the genus Tribonema are candidates for production of biofuels and other bioproducts. We report on a filamentous isolate from an outdoor raceway polyculture growing on municipal reclaimed wastewater which we classified as T. minus. Over one year of cultivation in 3.5 m2 raceway ponds fed by reclaimed municipal wastewater, T. minus cultures were more productive than the native algal polycultures, with annual average productivities of 15.9 ± 0.3 and 13.4 ± 0.4 g/m2/day, respectively. The biochemical composition of T. minus biomass grown outdoors was constant year-round, with 28.3 ± 0.4% carbohydrates, 37.6 ± 0.7% proteins, and 6.1 ± 0.3% fatty acids (measured as methyl esters), with up to 4.0% of the valuable omega-3 eicosapentaenoic acid, on an ash-free dry-weight basis. In summary, T. minus was more productive, easier to harvest and produced higher quality biomass than the native polycultures.

Chlorella vulgaris growth on anaerobically digested sugarcane vinasse: influence of turbidity

Autor: Mayara L Serejo

An Acad Bras Cienc. 2021 Apr 23;93(1):e20190084. doi: 10.1590/0001-3765202120190084. eCollection 2021.

ABSTRACT

This paper shows the influence of turbidity (in Nephelometric Turbidity Units - NTU), chemical oxygen demand (COD) and aeration (CO2 supply) on the productivity and growth rate and lipid content of microalgae (a mixed culture predominantly composed of Chlorella vulgaris), using anaerobically digested vinasse as a culture medium. The microalgae can be cultivated in anaerobically digested vinasse, at turbidity and chemical oxygen demand of 690 NTU and 2.5 gCOD L -1, respectively, according to the modified Gompertz model, and removal of turbidity by filtration did not influence the microalgae productivity (≈ 77 mg L1 d1). Furthermore, aeration increased the productivity up to 139 mg L1 d1, with a biomass dry weight of 2.7 g L-1. Finally, a maximum lipid content of 265 mg L -1 was obtained, while a nitrogen removal of 98% was recorded for all conditions. Thus, the combination of anaerobic digestion followed by the use of the digestate for the cultivation of microalgae may be an efficient way to treat large quantities of this residue, in turn yielding large amounts of microalgae biomass, which can be transformed into fertilizer and biofuel.

Combined effect of salinity and pH on lipid content and fatty acid composition of Tisochrysis lutea

Autor: Adel W Almutairi

Saudi J Biol Sci. 2020 Dec;27(12):3553-3558. doi: 10.1016/j.sjbs.2020.07.027. Epub 2020 Jul 30.

ABSTRACT

The haptophyte microalga Tisochrysis lutea was heterotrophically grown in F2 medium with different combinations of pH and salinity. Growth, oil content and fatty acids (FAs) profile were determined under each set of conditions. The salinity was adjusted using NaCl at concentrations of 0.4, 0.6, 0.8, or 1.0 M, while pH was adjusted at 7, 8, or 9, and heterotrophic growth was performed using organic carbon in the form of sugar cane industry waste (CM). Fatty acid methyl esters (FAMEs) were identified by gas chromatography. The results showed that pH of 8.0 was the optimal for dry weight and oil production, regardless of the salinity level. At pH 8.0, growth at a salinity of 0.4 M NaCl was optimal for biomass accumulation (1.185 g L-1). Under these conditions, the maximum growth rate was 0.055 g L-1 d-1, with a doubling time of 17.5 h and a degree of multiplication of 2.198. Oil content was maximal (34.87%) when the salinity was 0.4 M and the pH was 9.0. The ratio of saturated to unsaturated FAs was affected by the pH value and salinity, in that unsaturated FAs increased to 58.09% of the total FAs, considerably greater than the value of 40.59% obtained for the control (0.4 M NaCl and pH 8.0).

Detrimental effect of UV-B radiation on growth, photosynthetic pigments, metabolites and ultrastructure of some cyanobacteria and freshwater chlorophyta

Autor: Mostafa M El-Sheekh

Int J Radiat Biol. 2021;97(2):265-275. doi: 10.1080/09553002.2021.1851060. Epub 2020 Dec 3.

ABSTRACT

BACKGROUND: Global warming directly influencing ozone layer depletion, which eventually is increasing ultraviolet radiation penetration having far-reaching impacts on living biota. This particularly influences the primary producer microalgae which are the basic unit of food webs in the aquatic habitats. Therefore, it is necessary to concentrate the research at this micro-level to understand the harmful impact of increased UV-B radiation ever before. Consequently, the present attempt aimed to focus on the influence of UV-B on growth criteria, photosynthetic pigments, some metabolites, and ultrastructure of the freshwater cyanobacteria, Planktothrix cryptovaginata (Microcoleaceae), Nostoc carneum (Nostocaceae), Microcystis aeruginosa

(Microcystaceae), the Chlorophyte Scenedesmus acutus (Scenedesmaceae), and the marine Cyanobacterium Microcystis (Microcystaceae).

METHODS: The cultures of investigated algae were subjected directly to different duration periods (1, 3, 5, and 7 h) of artificial UV-B in addition to unirradiated control culture and allowed to grow for 10 days, after which the algal samples were analyzed for growth, photosynthetic activities, primary metabolities and cellular ultrastructure.

RESULTS: A remarkable inhibitory influence of UV-B was observed on growth criteria (measured as optical density and dry weight) and photosynthetic pigments of P. cryptovaginata, N. carneum, M. aeruginosa, S. acutus, and marine Microcystis. Where increasing the exposure time of UV-B was accompanied by increased inhibition. The variation in carbohydrate and protein contents under UV stress was based on the exposure periods and the algal species. The variation in algal ultrastructure by UV-B stress was noticed by an Electron Microscope. Cells damage and lysis, cell wall and cell membrane ruptured and release of intracellular substances, loss of cell inclusion, plasmolysis and necrosis, or apoptosis of the algal cells were observed by exposure to 7 h of UV-B.

CONCLUSION: Exposure to UV-B has a marked harmful impact on the growth, pigments, and metabolic activity, as well as the cellular ultrastructure of some cyanobacteria and chlorophytes.

Development of robust models for rapid classification of microplastic polymer types based on near infrared hyperspectral images

Autor: Tomo Kitahashi

Anal Methods. 2021 Apr 28. doi: 10.1039/d1ay00110h. Online ahead of print.

ABSTRACT

Hyperspectral data in the near infrared range were examined for nine common types of plastic particles of 1 mm and 100-500 μm sizes on dry and wet glass fiber filters. Weaker peak intensities were detected for small particles compared to large particles, and the reflectances were weaker at longer wavelengths when the particles were measured on a wet filter. These phenomena are explainable due to the effect of the correlation between the particle size and the absorption of infrared light by water. We constructed robust classification models that are capable of classifying polymer types, regardless of particle size or filter conditions (wet vs. dry), based on hyperspectral data for small particles measured on wet filters. Using the models, we also successfully classified the polymer type of polystyrene beads covered with microalgae, which simulates the natural conditions of microplastics in the ocean. This study suggests that hyperspectral imaging techniques with appropriate classification models allow the identification of microplastics without the time- and labor-consuming procedures of drying samples and removing biofilms, thus enabling more rapid analyses.

Ecophysiological, morphological, and biochemical traits of free-living Diplosphaera chodatii (Trebouxiophyceae) reveal adaptation to harsh environmental conditions

Autor: Cynthia Medwed

Protoplasma. 2021 Feb 7. doi: 10.1007/s00709-021-01620-6. Online ahead of print.

ABSTRACT

Single-celled green algae within the Trebouxiophyceae (Chlorophyta) are typical components of terrestrial habitats, which often exhibit harsh environmental conditions for these microorganisms. This study provides a detailed overview of the ecophysiological, biochemical, and ultrastructural traits of an alga living on tree bark. The alga was isolated from a cypress tree in the Botanical Garden of Innsbruck (Austria) and identified by morphology and molecular phylogeny as Diplosphaera chodatii. Transmission electron microscopy after high-pressure freezing (HPF) showed an excellent preservation of the ultrastructure. The cell wall was bilayered with a smooth inner layer and an outer layer of polysaccharides with a fuzzy hair-like appearance that could possibly act as cell-cell adhesion mechanism and hence as a structural precursor supporting biofilm formation together with the mucilage observed occasionally. The photosynthetic-irradiance curves of D. chodatii indicated low light requirements without photoinhibition at high photon flux densities (1580 µmol photons m-2 s-1) supported by growth rate measurements. D. chodatii showed a high desiccation tolerance, as 85% of its initial value was recovered after controlled desiccation at a relative humidity of ~10%. The alga contained the low molecular weight carbohydrates sucrose and sorbitol, which probably act as protective compounds against desiccation. In addition, a new but chemically not elucidated mycosporine-like amino acid was detected with a molecular mass of 332 g mol-1 and an absorption maximum of 324 nm. The presented data provide various traits which contribute to a better understanding of the adaptive mechanisms of D. chodatii to terrestrial habitats.

Effect of Drying Methods on Lutein Content and Recovery by Supercritical Extraction from the Microalga Muriellopsis sp. (MCH35) Cultivated in the Arid North of Chile

Autor: Mari Carmen Ruiz-Domínguez

Mar Drugs. 2020 Oct 26;18(11):528. doi: 10.3390/md18110528.

ABSTRACT

In this study, we determined the effect of drying on extraction kinetics, yield, and lutein content and recovery of the microalga Muriellopsis sp. (MCH35) using the supercritical fluid extraction (SFE) process. The strain was cultivated in an open-raceways reactor in the presence of seawater culture media and arid outdoor conditions in the north of Chile. Spray-drying (SD) and freeze-drying (FD) techniques were used for dehydrating the microalgal biomass. Extraction

experiments were performed by using Box-Behnken designs, and the parameters were studied: pressure (30-50 MPa), temperature (40-70 °C), and co-solvent (0-30% ethanol), with a CO2 flow rate of 3.62 g/min for 60 min. Spline linear model was applied in the central point of the experimental design to obtain an overall extraction curve and to reveal extraction kinetics involved in the SFE process. A significant increase in all variables was observed when the level of ethanol (15-30% v/v) was increased. However, temperature and pressure were non-significant parameters in the SFE process. The FD method showed an increase in lutein content and recovery by 0.3-2.5-fold more than the SD method. Overall, Muriellopsis sp. (MCH35) is a potential candidate for cost-effective lutein production, especially in desert areas and for different biotechnological applications.

Effective lipid extraction from undewatered microalgae liquid using subcritical dimethyl ether

Autor: Quan Wang

Biotechnol Biofuels. 2021 Jan 9;14(1):17. doi: 10.1186/s13068-020-01871-0.

ABSTRACT

BACKGROUND: Recent studies of lipid extraction from microalgae have focused primarily on dewatered or dried samples, and the processes are simple with high lipid yield. Yet, the dewatering with drying step is energy intensive, which makes the energy input during the lipid production more than energy output from obtained lipid. Thus, exploring an extraction technique for just a thickened sample without the dewatering, drying and auxiliary operation (such as cell disruption) is very significant. Whereas lipid extraction from the thickened microalgae is complicated by the high water content involved, and traditional solvent, hence, cannot work well. Dimethyl ether (DME), a green solvent, featuring a high affinity for both water and organic compounds with an ability to penetrate the cell walls has the potential to achieve this goal.

RESULTS: This study investigated an energy-saving method for lipid extraction using DME as the solvent with an entrainer solution (ethanol and acetone) for flocculation-thickened microalgae. Extraction efficiency was evaluated in terms of extraction time, DME dosage, entrainer dosage, and ethanol:acetone ratio. Optimal extraction occurred after 30 min using 4.2 mL DME per 1 mL microalgae, with an entrainer dosage of 8% at 1:2 ethanol:acetone. Raw lipid yields and its lipid component (represented by fatty acid methyl ester) contents were compared against those of common extraction methods (Bligh and Dryer, and Soxhlet). Thermal gravimetry/differential thermal analysis, Fourier-transform infrared spectroscopy, and C/H/N elemental analyses were used to examine differences in lipids extracted using each of the evaluated methods. Considering influence of trace metals on biodiesel utilization, inductively coupled plasma mass spectrometry and inductively coupled plasma atomic emission spectroscopy analyses were used to quantify trace metals in the extracted raw lipids, which revealed relatively high concentrations of Mg, Na, K, and Fe.

CONCLUSIONS: Our DME-based method recovered 26.4% of total raw lipids and 54.4% of total fatty acid methyl esters at first extraction with remnants being recovered by a 2nd extraction.

In additional, the DME-based approach was more economical than other methods, because it enabled simultaneous dewatering with lipid extraction and no cell disruption was required. The trace metals of raw lipids indicated a purification demand in subsequent refining process.

Effects of different phosphorus concentrations on growth and biochemical composition of Desmodesmus communis (E.Hegewald) E.Hegewald

Autor: Rıza Akgül

Prep Biochem Biotechnol. 2020 Dec 7:1-9. doi: 10.1080/10826068.2020.1853156. Online ahead of print.

ABSTRACT

The members of the family Scenedesmaceae has the most widely used microalgae species in algal biotechnology studies because of their fast growth rate, quality of nutrition content and lipid accumulation under nutrient-limiting conditions. However, the biochemical responses of the species under phosphorus (P) limiting conditions are still unknown. The growth and biochemical composition of Desmodesmus communis in response to different phosphorus concentrations were investigated in this research. Five different phosphorus conditions were used: control (BG11); excess treatments (50% P+, 75% P+) and limited treatments (50% P-, 75% P-The highest cell concentration was observed in 75% P+ (725.6 × 104 cells/mL), whereas the highest dry weight concentration (1.81 mg/L) was found in 50% P- medium. The highest total lipid (4.94%) accumulation was found in the 50% P + medium and the maximum protein (49.5%) content was detected in 50% P- medium. Fatty acid and amino acid compositions change according to P concentration. PUFAs concentrations are higher than SFAs and MUFAs. Therefore the microalgae biomass obtained from this study cannot be used for biodiesel production although it is more suitable for nutritional supplement productions.

Effects of fluctuating temperature in open raceway ponds on the biomass accumulation and harvest efficiency of Spirulina in large-scale cultivation

Autor: Xiufen Wang

Environ Sci Pollut Res Int. 2021 Apr;28(16):20794-20802. doi: 10.1007/s11356-020-11914-6. Epub 2021 Jan 6.

ABSTRACT

It is of great significance to select strains with wide adaptability to temperature range for large-scale commercial cultivation of Spirulina. The aim of this study was to comprehend how the strain H-208 grew and whether this strain had any advantages in temperature adaptation compared with local production strain during the large-scale cultivation in Inner Mongolia. The

results showed that the strain H-208 could adapt to the new environmental condition quickly, and the daily average biomass dry weight of strain H-208 was 49% and 52% more than that of production strain M-1 in first cycle (20.24 g/m2/day) and second cycle (16.90 g/m2/day) of acclimation experiment, respectively. The growth rate of strain H-208 was 0.055 and 0.066 g/L/day from July 22 to July 25 and from July 26 to July 29, respectively, while the growth rate of strain M-1 was only 0.036 and 0.032 g/L/day, respectively, during the same cultured days in 605-m2 raceway ponds before high temperature. The harvesting efficiency of H-208 and M-1 was 95.1% and 72.1% before high temperature, and that was 95.3% and 52.5% after being stressed by high temperature, respectively. Meanwhile, it was also observed that the filaments of the two strains contracted and their pitches were smaller than that before high temperature stress, especially the strain M-1. In 20-m2 raceway ponds of recovery experiment after high temperature, the percentage of daily average biomass dry weight of strain H-208 was 68% more than that of strain M-1, which demonstrated that strain H-208 could recover and grow rapidly, and its self-regulation ability was superior to that of strain M-1.

Effects of light intensity and nutrients on the lipid content of marine microalga (diatom) Amphiprora sp. for promising biodiesel production

Autor: Saravanan Jayakumar

Sci Total Environ. 2021 May 10;768:145471. doi: 10.1016/j.scitotenv.2021.145471. Epub 2021 Jan 30.

ABSTRACT

In this research investigation, three microalgal species were screened (Pleurosigma sp., Amphora sp., and Amphiprora sp.) for lipid content before choosing the potential microalgae for biodiesel production. It was found that the lipid content of Amphiprora sp. was 41.48 ± 0.18%, which was higher than the Pleurosigma sp. (27.3 ± 0.8%) and Amphora sp. (22.49 ± 0.21%). The diatom microalga, Amphiprora sp. was isolated and exposed to a controlled environment. Two different media were prepared, and the main research was on the SiO2-NP medium as the cell wall of diatom was made up of silica. Essential growth parameters were studied such as dry cell weight and chlorophyll a content. The results revealed that Amphiprora sp. cultured in the modified medium showed a higher biomass yield and growth rate in all the analyses. In Soxhlet extraction method, biodiesel yield of Amphiprora sp. in modified medium under 24 μmol m-2 s-1 of light intensity was 81.47 ± 1.59% when using 2% of catalyst amount with 1.5:1 volume ratio of methanol/oil in 3 h reaction time at 65 °C. Results reveled that Amphiprora sp. diatom has a higher yield of oil 52.94 ± 0.42% and can be efficiently optimized with further studies with modified nanomaterial culture medium. The present research revealed the series of experiments on microalgal lipid transesterification and in future investigation different types of nanomaterials should be used in culture medium to identify the lipid production in microalgal cells.

Efficient extraction and preservation of thermotolerant phycocyanins from red alga Cyanidioschyzon merolae

Autor: Chihiro Yoshida

J Biosci Bioeng. 2021 Feb;131(2):161-167. doi: 10.1016/j.jbiosc.2020.09.021. Epub 2020 Oct 24.

ABSTRACT

C-Phycocyanin (PC) is a protein used commercially as a natural blue pigment produced by cyanobacteria, cryptophytes, and rhodophytes. Although it is industrially synthesized from the cyanobacterium Arthrospira platensis, PC requires high levels of energy for its extraction, which involves freezing of cells. However, as a protein, PC is easily denatured at extreme temperatures. In this study, we extracted PC from the red alga Cyanidioschyzon merolae, denoted as CmPC, and found that this protein was tolerant to high temperatures and acidic pH. CmPC was extracted by suspending cells in water mixed with various salts and organic acids without freeze-drying or freeze-thaw. The stability of CmPC varied with salt concentration and was destabilized by organic acids. Our results indicate that C. merolae is a potential candidate for PC production with thermotolerant properties.

Electrocoagulation reduces harvesting costs for microalgae

Autor: Simona Lucakova

Bioresour Technol. 2021 Mar;323:124606. doi: 10.1016/j.biortech.2020.124606. Epub 2020 Dec 23.

ABSTRACT

Centrifugation is the most commonly used method for harvesting autotrophically produced microalgae, but it is expensive due to high energy demands. With the aim of reducing these costs, we tested electrocoagulation with iron electrodes for harvesting Chlorella vulgaris. During extensive lab-scale experiments, the following factors were studied to achieve a high harvesting efficiency and a low iron content in the harvested biomass: electric charge, initial biomass concentration, pH, temperature, agitation intensity, residual salt content and electrolysis time. A harvesting efficiency greater than 95% was achieved over a broad range of conditions and the residual iron content in the biomass complied with legislative requirements for food. Using electrocoagulation as the pre-concentration step prior to centrifugation, total energy costs were reduced to 0.136 kWh/kg of dry biomass, which is less than 14% of that for centrifugation alone. Our data show that electrocoagulation is a suitable and cost-effective method for harvesting microalgae.

Electrorotation of single microalgae cells during lipid accumulation for assessing cellular dielectric properties and total lipid contents

Autor: Yu-Sheng Lin

Biosens Bioelectron. 2020 Nov 2;173:112772. doi: 10.1016/j.bios.2020.112772. Online ahead of print.

ABSTRACT

Photosynthetic microalgae not only perform fixation of carbon dioxide but also produce valuable byproducts such as lipids and pigments. However, due to the lack of effective tools for rapid and noninvasive analysis of microalgal cellular contents, the efficiency of strain screening and culture optimizing is usually quite low. This study applied single-cell electrorotation on Scenedesmus abundans to assess cellular dielectric properties during lipid accumulation and to promptly quantify total cellular contents. The experimental electrorotation spectra were fitted with the double-shell ellipsoidal model, which considered varying cell wall thickness, to obtain the dielectric properties of cellular compartments. When the amount of total lipids increased from 15.3 wt% to 33.8 wt%, the conductivity and relative permittivity of the inner core (composed of the cytoplasm, lipid droplets, and nucleus) decreased by 21.7% and 22.5%, respectively. These dielectric properties were further used to estimate the total cellular lipid contents by the general mixing formula, and the estimated values agreed with those obtained by weighing dry biomass and extracted lipids with an error as low as 0.22 wt%. Additionally, the conductivity and relative permittivity of cell wall increased during nitrogen-starvation conditions, indicating the thickening of cell wall, which was validated by the transmission electron microscopy.

Enhanced Arthrospira platensis Biomass Production Combined with Anaerobic Cattle Wastewater Bioremediation

Autor: Denise Salvador de Souza

Bioenergy Res. 2021 Feb 28:1-14. doi: 10.1007/s12155-021-10258-4. Online ahead of print.

ABSTRACT

Microalgae biomasses offer important benefits regarding macromolecules that serve as promising raw materials for sustainable production. In the present study, the microalgae Arthrospira platensis DHR 20 was cultivated in horizontal photobioreactors (HPBR), with and without temperature control, in batch mode (6 to 7 days), with anaerobically digested cattle wastewater (ACWW) as substrate. High dry biomass concentrations were observed (6.3-7.15 g L-1). Volumetric protein, carbohydrate, and lipid productivities were 0.299, 0.135, and 0.108 g L-1 day-1, respectively. Promising lipid productivities per area were estimated between 22.257 and 39.446 L ha-1 year-1. High CO2 bio-fixation rates were recorded (875.6-1051 mg L-1 day-1), indicating the relevant potential of the studied microalgae to mitigate atmospheric pollution. Carbon concentrations in biomass ranged between 41.8 and 43.6%. ACWW bioremediation was satisfactory, with BOD5 and COD removal efficiencies of 72.2-82.6% and 63.3-73.6%.

Maximum values of 100, 95.5, 92.4, 80, 98, and 94% were achieved concerning the removal of NH4 +, NO3 -, Pt, SO4 2-, Zn, and Cu, respectively. Total and thermotolerant coliform removals reached 99-99.7% and 99.7-99.9%. This microalgae-mediated process is, thus, promising for ACWW bioremediation and valuation, producing a microalgae biomass rich in macromolecules that can be used to obtain friendly bio-based products and bioenergy.

Enhanced fatty acid methyl esters recovery through a simple and rapid direct transesterification of freshly harvested biomass of Chlorella vulgaris and Messastrum gracile

Autor: Saw Hong Loh

Sci Rep. 2021 Feb 1;11(1):2720. doi: 10.1038/s41598-021-81609-6.

ABSTRACT

Conventional microalgae oil extraction applies physicochemical destruction of dry cell biomass prior to transesterification process to produce fatty acid methyl esters (FAMEs). This report presents a simple and rapid direct transesterification (DT) method for FAMEs production and fatty acid profiling of microalgae using freshly harvested biomass. Results revealed that the FAMEs recovered from Chlorella vulgaris were 50.1 and 68.3 mg with conventional oil-extraction-transesterification (OET) and DT method, respectively. While for Messastrum gracile, the FAMEs recovered, were 49.9 and 76.3 mg, respectively with OET and DT methods. This demonstrated that the DT method increased FAMEs recovery by 36.4% and 53.0% from C. vulgaris and M. gracile, respectively, as compared to OET method. Additionally, the DT method recovered a significantly higher amount of palmitic (C16:0) and stearic (C18:0) acids from both species, which indicated the important role of these fatty acids in the membranes of cells and organelles. The DT method performed very well using a small volume (5 mL) of fresh biomass coupled with a shorter reaction time (~ 15 min), thus making real-time monitoring of FAMEs and fatty acid accumulation in microalgae culture feasible.

Evaluation of Thirty Microalgal Isolates as Biodiesel Feedstocks Based on Lipid Productivity and Triacylglycerol (TAG) Content

Autor: Enver Ersoy Andeden

Curr Microbiol. 2021 Feb;78(2):775-788. doi: 10.1007/s00284-020-02340-5. Epub 2021 Jan 21.

ABSTRACT

Microalgae are considered feedstock for biodiesel production due to their capability to accumulate triacylglycerols, which have a 99% conversion rate into biodiesel, under certain conditions. This study aims to evaluate thirty native microalgal strains as feedstock for biodiesel

production based on their biomass and lipid productivities, and total lipid and triacylglycerol contents under nitrogen-sufficient and nitrogen starvation conditions. In addition, Chlamydomonas reinhardtii cw15 mutant strain was utilized as a reference strain for triacylglycerol accumulation. Among the eight potent strains, Chlorella vulgaris KP2 was considered as a most promising strain with the highest triacylglycerol content, highest total lipid content (28.56% of dry cell weight), and the highest lipid productivity (4.56 mg/L/day) under nitrogen starvation. Under nitrogen starvation, the major fatty acids in the triacylglycerol of Chlorella vulgaris KP2 were C18:1 (37.56%), C16:0 (23.16%), C18:0 (23.07), C18:2 (7.00%), and C18:3 (3.12%), and the percentages of saturated fatty acids, monounsaturated fatty acids, and polyunsaturated fatty acids represented 49.26, 38.73, and 10.12% of the total fatty acids, respectively. Furthermore, the fatty acid methyl esters of triacylglycerol displayed remarkable biodiesel properties with a lower iodine value (59.00 gI2/100 g), higher oxidative stability (14.24 h) and higher cetane number (58.73) under nitrogen starvation. This study suggests that nitrogen-starved Chlorella vulgaris KP2 could be used as a feedstock for biodiesel production due to the considerable amounts of triacylglycerol and favorable biodiesel properties.

Evaluation of antioxidant and anticancer activity of crude extract and different fractions of Chlorella vulgaris axenic culture grown under various concentrations of copper ions

Autor: Eman A El-Fayoumy

BMC Complement Med Ther. 2021 Feb 5;21(1):51. doi: 10.1186/s12906-020-03194-x.

ABSTRACT

BACKGROUND: Chlorella vulgaris is a microalga potentially used for pharmaceutical, animal feed, food supplement, aquaculture and cosmetics. The current study aims to study the antioxidant and prooxidant effect of Chlorella vulgaris cultivated under various conc. of copper ions.

METHODS: The axenic green microalgal culture of Chlorella vulgaris was subjected to copper stress conditions (0.00, 0.079, 0.158, 0.316 and 0.632 mg/L). The growth rate was measured at OD680 nm and by dry weight (DW). Moreover, the Antioxidant activity against DPPH and ABTS radical, pigments and phytochemical compounds of the crude extracts (methylene chloride: Methanol, 1:1) were evaluated. The promising Cu crude extract (0.316 mg/L) further fractionated into twenty-one fractions by silica gel column chromatography using hexane, chloroform and ethyl acetate as a mobile phase.

RESULTS: The obtained results reported that nine out of these fractions exhibited more than 50% antioxidant activity and anticancer activity against Hela cancer cell lines. Based on IC50, fraction No. 7 was found to be the most effective fraction possessing a significant increase in both antioxidant and anticancer potency. Separation of active compound (s) in fraction No 7 was performed using precoated silica gel plates (TLC F254) with ethyl acetate: hexane (9:1 v/v) as mobile phase. Confirmation of active compound separation was achieved by two-dimensional TLC and visualization of the separated compound by UV lamp. The complete identification of the separated active compound was performed by UV- Vis- spectrophotometric absorption, IR, MS, H1-NMRT C13-NMR. The isolated compound ((2E,7R,11R)-3,7,11,15-Tetramethyl-2-

hexadecenol) have high antioxidant activity with IC50 (10.59 µg/ml) against DPPH radical assay and comparable to the capacities of the positive controls, Butylated hydroxy toluene [BHT] (IC50 11.2 µg/ml) and Vitamin C (IC50 12.9 µg/ml). Furthermore, pure isolated compound exhibited a potent anticancer activity against Hela cell line with IC50 (4.38 µg/ml) compared to Doxorubicin (DOX) as synthetic drug (13.3 µg/ml). In addition, the interaction of the pure compound with Hela cancer cell line and gene expression were evaluated.

CONCLUSIONS: The authors recommend cultivation of Chlorella vulgaris in large scale under various stress conditions for use the crude extracts and semi purified fractions for making a pharmaco-economic value in Egypt and other countries.

Experimental freezing of freshwater pennate diatoms from polar habitats

Autor: Eva Hejduková

Protoplasma. 2021 Apr 28. doi: 10.1007/s00709-021-01648-8. Online ahead of print.

ABSTRACT

Diatoms are microalgae that thrive in a range of habitats worldwide including polar areas. Remarkably, non-marine pennate diatoms do not create any morphologically distinct dormant stages that could help them to successfully face unfavourable conditions. Their survival is probably connected with the adaptation of vegetative cells to freezing and desiccation. Here we assessed the freezing tolerance of vegetative cells and vegetative-looking resting cells of 12 freshwater strains of benthic pennate diatoms isolated from polar habitats. To test the effect of various environmental factors, the strains were exposed to -20 °C freezing in four differently treated cultures: (1) vegetative cells growing in standard conditions in standard WC medium and (2) resting cells induced by cold and dark acclimation and resting cells, where (3) phosphorus or (4) nitrogen deficiency were used in addition to cold and dark acclimation. Tolerance was evaluated by measurement of basal cell fluorescence of chlorophyll and determination of physiological cell status using a multiparameter fluorescent staining. Four strains out of 12 were able to tolerate freezing in at least some of the treatments. The minority of cells appeared to be active immediately after thawing process, while most cells were inactive, injured or dead. Overall, the results showed a high sensitivity of vegetative and resting cells to freezing stress among strains originating from polar areas. However, the importance of resting cells for survival was emphasized by a slight but statistically significant increase of freezing tolerance of nutrient-depleted cells. Low numbers of surviving cells in our experimental setup could indicate their importance for the overwintering of diatom populations in harsh polar conditions.

Filamentous microalgae as an advantageous co-substrate for enhanced methane production and digestate dewaterability in anaerobic co-digestion of pig manure

Autor: Yuansheng Hu

Waste Manag. 2021 Jan 1;119:399-407. doi: 10.1016/j.wasman.2020.10.041. Epub 2020 Nov 13.

ABSTRACT

This study aimed at exploring filamentous microalgae (Tribonema sp.) as an advantageous co-substrate for anaerobic digestion (AD) of pig manure. Its impacts on the AD performance were assessed in terms of methane yield, energy conversion efficiency, digestion kinetics, and digestate dewaterability. The microalgae substantially improved methane yield, AD kinetics, and digestate dewaterability of the AD process. The enhancement in methane yield ranged from 2 to 27.4%, with the maximum enhancement (corresponding to an energy conversion efficiency of 81%) occurring at a mixing ratio of 1:1 (VS basis). The AD kinetics was improved as indicated by the increased hydrolysis rate constants and diminished lag time. The specific resistance to filtration (SRF) of the digestate decreased significantly with the increasing proportion of the microalgae in the co-substrates, which would facilitate digestate processing and valorisation. Subsequently, the high biomass productivity of the microalgae (441 mg/L/d) in liquid digestate would enable sustainable bioenergy production through nutrient recycling.

Food web biomagnification of the neurotoxin β-N-methylamino-L-alanine in a diatom-dominated marine ecosystem in China

Autor: Chao Wang

J Hazard Mater. 2021 Feb 15;404(Pt B):124217. doi: 10.1016/j.jhazmat.2020.124217. Epub 2020 Oct 8.

ABSTRACT

The neurotoxin β-N-methylamino-L-alanine (BMAA) reported in some cyanobacteria and eukaryote microalgae is a cause of concern due to its potential risk of human neurodegenerative diseases. Here, BMAA distribution in phytoplankton, zooplankton, and other marine organisms was investigated in Jiaozhou Bay, China, a diatom-dominated marine ecosystem, during four seasons in 2019. Results showed that BMAA was biomagnified in the food web from phytoplankton to higher trophic levels. Trophic magnification factors (TMFs) for zooplankton, bivalve mollusks, carnivorous crustaceans and carnivorous gastropod mollusks were ca. 4.58, 30.1, 42.5, and 74.4, respectively. Putative identification of β-amino-N-methylalanine (BAMA), an isomer of BMAA, was frequently detected in phytoplankton samples. A total of 56 diatom strains of the genera Pseudo-nitzschia, Thalassiosira, Chaetoceros, Planktoniella, and Minidiscus isolated from the Chinese coast were cultured in the laboratory, among which 21 strains contained BMAA mainly in precipitated bound form at toxin concentrations ranging from 0.11 to 3.95 μg/g dry weight. Only 2,4-diaminobutyric acid (DAB) but not BMAA or BAMA was detected in seven species of bacteria isolated from the gut of gastropod Neverita didyma, suggesting that this benthic vector of BMAA may have accumulated this compound via trophic transfer.

Global Metabolomics Reveals That Vibrio natriegens Enhances the Growth and Paramylon Synthesis of Euglena gracilis

Autor: Ying Ouyang

Front Bioeng Biotechnol. 2021 Mar 31;9:652021. doi: 10.3389/fbioe.2021.652021. eCollection 2021.

ABSTRACT

The microalga Euglena gracilis is utilized in the food, medicinal, and supplement industries. However, its mass production is currently limited by its low production efficiency and high risk of microbial contamination. In this study, physiological and biochemical parameters of E. gracilis co-cultivated with the bacteria Vibrio natriegens were investigated. A previous study reports the benefits of E. gracilis and V. natriegens co-cultivation; however, no bacterium growth and molecular mechanisms were further investigated. Our results show that this co-cultivation positively increased total chlorophyll, microalgal growth, dry weight, and storage sugar paramylon content of E. gracilis compared to the pure culture without V. natriegens. This analysis represents the first comprehensive metabolomic study of microalgae-bacterial co-cultivation, with 339 metabolites identified. This co-cultivation system was shown to have synergistic metabolic interactions between microalgal and bacterial cells, with a significant increase in methyl carbamate, ectoine, choline, methyl N-methylanthranilate, gentiatibetine, 4R-aminopentanoic acid, and glu-val compared to the cultivation of E. gracilis alone. Taken together, these results fill significant gaps in the current understanding of microalgae-bacteria co-cultivation systems and provide novel insights into potential improvements for mass production and industrial applications of E. gracilis.

High Productivity of Eicosapentaenoic Acid and Fucoxanthin by a Marine Diatom Chaetoceros gracilis in a Semi-Continuous Culture

Autor: Saki Tachihana

Front Bioeng Biotechnol. 2020 Dec 11;8:602721. doi: 10.3389/fbioe.2020.602721. eCollection 2020.

ABSTRACT

Significantly high eicosapentaenoic acid (EPA) and fucoxanthin contents with high production rate were achieved in semi continuous culture of marine diatom. Effects of dilution rate on the production of biomass and high value biocompounds such as EPA and fucoxanthin were evaluated in semi-continuous cultures of Chaetoceros gracilis under high light condition. Cellular dry weight increased at lower dilution rate and higher light intensity conditions, and cell size strongly affected EPA and fucoxanthin contents. The smaller microalgae cells showed significantly higher ($p < 0.05$) value of 17.1 mg g-dw-1 fucoxanthin and 41.5% EPA content per total fatty acid compared to those observed in the larger cells. Chaetoceros gracilis can accumulate relatively higher EPA and fucoxanthin than those reported previously. In addition,

maintenance of small cell size by supplying sufficient nutrients and light energy can be the key for the increase production of valuable biocompounds in C. gracilis.

High cell density cultivation enables efficient and sustainable recombinant polyamine production in the microalga Chlamydomonas reinhardtii

Autor: Robert A Freudenberg

Bioresour Technol. 2021 Mar;323:124542. doi: 10.1016/j.biortech.2020.124542. Epub 2020 Dec 15.

ABSTRACT

Modern chemical industry calls for new resource-efficient and sustainable value chains for production of key base chemicals such as polyamines. The green microalga Chlamydomonas reinhardtii offers great potential as an innovative green-cell factory by combining fast and inexpensive, phototrophic growth with mature genetic engineering. Here, overexpression of recombinant lysine decarboxylases in C. reinhardtii enabled the robust accumulation of the non-native polyamine cadaverine, which serves as building block for bio-polyamides. The issue of low cell densities, limiting most microalgal cultivation processes was resolved by systematically optimizing cultivation parameters. A new, easy-to-apply and fully phototrophic medium enables high cell density cultivations of C. reinhardtii with a 6-fold increase in biomass and cell count (20 g/L biomass dry weight, ~2·108 cells/mL). Application of high cell density cultivations in established photobioreactors resulted in a 10-fold increase of cadaverine yields, with up to 0.24 g/L after 9 days and maximal productivity of 0.1 g/L/d.

Hydroclimatic and cultural instability in northeastern North America during the last millennium

Autor: J Curt Stager

PLoS One. 2021 Mar 26;16(3):e0248060. doi: 10.1371/journal.pone.0248060. eCollection 2021.

ABSTRACT

Long-term, large-scale perspectives are necessary for understanding climate variability and its effects on ecosystems and cultures. Tree ring records of the Medieval Climate Anomaly (MCA) and Little Ice Age (LIA) have documented major hydroclimatic variability during the last millennium in the American West, but fewer continuous, high-resolution hydroclimate records of the MCA-LIA period are available for eastern North America, particularly during the transition from the MCA to the LIA (ca. A.D. 1250-1400). Diatoms (micro-algae with silica cell walls) in sediment cores from three Adirondack (NY, USA) lakes and a hiatus in a wetland peat deposit in the Adirondack uplands provide novel insights into the late Holocene hydroclimate history of the

Northeast. These records demonstrate that two of the region's most extreme decadal-scale droughts of the last millennium occurred ca. A.D. 1260-1330 and ca. A.D. 1360-1390 during a dry-wet-dry (DWD) oscillation in the Adirondacks that contributed to forest fires and desiccation of wetlands in New York and Maine. The bimodal drying was probably related to more extreme droughts farther west and coincided with major events in Iroquoian and Abenaki cultural history. Although the causes of the DWD oscillation in the Adirondacks remain uncertain, changing sea-surface temperatures and solar variability are likely to have played a role.

In vitro bioaccessibility of macular xanthophylls from commercial microalgal powders of Arthrospira platensis and Chlorella pyrenoidosa

Autor: Cristina Tudor

Food Sci Nutr. 2021 Feb 16;9(4):1896-1906. doi: 10.1002/fsn3.2150. eCollection 2021 Apr.

ABSTRACT

The bioaccessibility of the major carotenoids present in two commercial microalgal supplements in powder form was investigated through a standardized in vitro digestion method. The dried biomass of Arthrospira platensis contained β-carotene (36.8 mg/100 g) and zeaxanthin (20.8 mg/100 g) as the main carotenoids as well as a high content of saturated fatty acids (61% of total fatty acids), whereas that of Chlorella pyrenoidosa was rich in lutein (37.8 mg/100 g) and had a high level of unsaturated fatty acids (65% of total fatty acids). In the case of the latter, lutein bioaccessibility was not statistically enhanced after the replacement of porcine bile extract with bovine bile extract in the in vitro digestion protocol and after the addition of coconut oil (17.8% as against to 19.2% and 19.2% vs. 18.5%, respectively). In contrast, the use of bovine bile extract along with co-digestion with coconut oil significantly enhanced the bioaccessibility of zeaxanthin from A. platensis, reaching the highest bioaccessibility of 42.8%.

Influence of Nitrogen to Phosphorus Ratio and CO2 Concentration on Lipids Accumulation of Scenedesmus dimorphus for Bioenergy Production and CO2 Biofixation

Autor: Mohammed Omar Faruque

Chem Asian J. 2020 Dec 14;15(24):4307-4320. doi: 10.1002/asia.202001063. Epub 2020 Nov 16

ABSTRACT

The potential of Scenedesmus dimorphus microalgae for CO2 biofixation and lipid biosynthesis for bioenergy applications was evaluated in this study. Batch experiments were conducted using synthetic tertiary municipal wastewater samples at several nitrogen to phosphorus (NP) ratios (1 : 1 to 8 : 1) and CO2 concentrations (~0%, 2%, 4%, and 6% CO2 in supplied air).

Scenedesmus dimorphus was cultivated for 25 days and the growth is highly dependent on the CO2 concentration and the NP ratio. An NP ratio of 2 : 1 produces a biomass yield of 733 mg/L when the microalga culture was supplied with air enriched with 2% CO2 . The maximum CO2 biofixation rate of 49.6 mg L-1 d-1 is at an NP ratio of 8 : 1 with 4% CO2 . A colorimetric technique depending on sulpho-phospho-vanillin (SPV) was utilized for the determination of the intracellular lipid content. The highest lipid content of 31.6% as the dry weight of the biomass is at an NP ratio of 1 : 1 and 6% CO2 . These results indicate that supplementation of suitable CO2 with favorable NP ratio has a considerable effect on lipid accumulation in the microalgae Scenedesmus dimorphus biomass

Influence of abiotic factors on the growth of Cyanobacteria isolated from Nakdong river, South Korea

Autor: Seema Yadav

J Phycol. 2021 Feb 8. doi: 10.1111/jpy.13143. Online ahead of print.

ABSTRACT

Changes in physico-chemical factors due to natural climate variability and eutrophication could affect the cyanobacterial growth patterns in aquatic systems that may cause environmental health problems. Based on morphological and 16S rRNA gene analysis, three cyanobacterial species isolated for the first time from the Nakdong River water sample in South Korea were identified as Amazoninema brasiliense, Microcystis elabens, and Nododsilinea nodulosa. The variations in temperature, pH, nitrogen, or phosphorus levels significantly impacted the cyanobacterial growth patterns. The optimal temperature range for the growth of isolates was from 25-30°C. A neutral or weak alkaline environment favored growth; however, A. brasiliense resulted in 44.2~87.5 % higher biomass (0.75 g · L-1 as dry solids, DS) and growth rate (0.24 · d-1) at pH 7 than the other isolates (0.4~0.52 g DS · L-1 , 0.16~0.19 · d-1). The increased nitrate-nitrogen (NO3 -N) concentrations significantly ($P < 0.05$) favored biomass production and growth rate for A. brasiliense and M. elabens, respectively, and the maximum growth rate was observed for A. brasiliense at 3.5 mg NO3 -N · L-1 . The orthophosphate concentration (PO4 -P) from 0.1 to 0.5 mg PO4 -P · L-1 increased the growth of the isolates. These observations suggest that isolate growth rates in water bodies can vary depending on different physico-chemical parameters. This study contributes to the further understanding the growth of microalgae in natural freshwater bodies under fluctuating environmental conditions and aquatic ecosystem stability.

Innovative membrane photobioreactor for sustainable CO2 capture and utilization

Autor: Vincenzo Senatore

Chemosphere. 2021 Jan 18;273:129682. doi: 10.1016/j.chemosphere.2021.129682. Online ahead of print.

ABSTRACT

The rising of greenhouse-gas emissions (GHG), during the last 200 years, is associated to the well known global warming phenomena. One of the main sources of CO2-equivalent GHGs emissions are the environmental protection plants accounting for 1.57% of the global emissions and thus sustainable and effective technologies for their mitigation are strongly needed. The current paper presents and discusses the assessment of an innovative membrane photo-bioreactor (MPBR) whose aim was the promotion of CO2 capture from conveyed flows, such as those from wastewater treatment plants (WWTPs), landfill and composting plants, for production and energy valorisation of algal biomass. Chlorella vulgaris microalgae strain was selected as photosynthetic platform for the abovementioned purposes. The influence of various operating parameters has been explored, including the photosynthetic photon flux densities (PPFD) (60 and 120 μmol m-2 s-1), liquid/gas ratio (L/G = 5, 10 or 15) and CO2 concentration (5, 10 and 15%) in order to investigated their effects on carbon capture effectiveness and biomass production. The results demonstrated that the increasing of PPFD significantly enhanced the biomass production in terms of biomass productivity (P) and total dry weight (DW). The highest biomass concentration of 1.01 g L-1 was achieved at PPFD of 120 μmol m-2 s-1 with a L/G of 15. Under the aforementioned conditions, carbon dioxide removal efficiency (RE) reached values up to 80%. In addition, the novel MPBR equipped with an innovative self-forming dynamic membrane (SFDM) showed a simultaneous biomass harvesting rate of 41 g m-2 h-1.

Insights into the physiology of Chlorella vulgaris cultivated in sweet sorghum bagasse hydrolysate for sustainable algal biomass and lipid production

Autor: Neha Arora

Sci Rep. 2021 Mar 24;11(1):6779. doi: 10.1038/s41598-021-86372-2.

ABSTRACT

Supplementing cultivation media with exogenous carbon sources enhances biomass and lipid production in microalgae. Utilization of renewable organic carbon from agricultural residues can potentially reduce the cost of algae cultivation, while enhancing sustainability. In the present investigation a medium was developed from sweet sorghum bagasse for cultivation of Chlorella under mixotrophic conditions. Using response surface methodology, the optimal values of critical process parameters were determined, namely inoculum cell density (O.D.750) of 0.786, SSB hydrolysate content of the medium 25% v/v, and zero medium salinity, to achieve maximum lipid productivity of 120 mg/L/d. Enhanced biomass (3.44 g/L) and lipid content (40% of dry cell weight) were observed when the alga was cultivated in SSB hydrolysate under mixotrophic conditions compared to heterotrophic and photoautotrophic conditions. A time course investigation revealed distinct physiological responses in terms of cellular growth and biochemical composition of C. vulgaris cultivated in the various trophic modes. The determined carbohydrate and lipid profiles indicate that sugar addition to the cultivation medium boosts neutral lipid synthesis compared to structural lipids, suggesting that carbon flux is channeled towards triacylglycerol synthesis in the cells. Furthermore, the fatty acid profile of lipids extracted from mixotrophically grown cultures contained more saturated and monosaturated fatty acids, which are suitable for biofuel manufacturing. Scale-up studies in a photobioreactor

using SSB hydrolysate achieved a biomass concentration of 2.83 g/L consisting of 34% lipids and 26% carbohydrates. These results confirmed that SSB hydrolysate is a promising feedstock for mixotrophic cultivation of Chlorella and synthesis of algal bioproducts and biofuels.

Insights on the intestinal absorption of chlorophyll series from microalgae

Autor: Andrêssa S Fernandes

Food Res Int. 2021 Feb;140:110031. doi: 10.1016/j.foodres.2020.110031. Epub 2020 Dec 18.

ABSTRACT

The bioaccessibility and subsequent uptake by Caco-2 human intestinal cells of chlorophyll pigments from Scenedesmus obliquus were determined for the first time. In order to evaluate the impact of different types of the matrix on bioaccessibility of chlorophyll from microalgae, three different products were evaluated: isolated chlorophyll extract (ICE); wet ultrasonicated biomass (WUB); and whole dried biomass (WDB). The samples were submitted to in vitro digestion model according to the INFOGEST protocol, and Caco-2 cells determined the intestinal uptake. Chlorophyll pigments were determined by HPLC-PDA-MS/MS. A total of ten chlorophyll pigments (8,318.48 μg g-1) were separated in S. obliquus biomass, with chlorophyll a (3,507.76 μg g-1) and pheophytin a' (1,598.09 μg g-1) the major ones. After in vitro digestion, all tested products showed bioaccessible chlorophylls. However, the total bioaccessibility results were as follows: ICE (33.45%), WUB (2.65%), WDB (0.33%). Five compounds were bioaccessible in ICE, three in WUB, and one in WDB. The hydroxypheophytin a showed the highest bioaccessibility (212%) in ICE, while pheophytin a' in WUB (11%) and WDB (2%). As a result, bioavailability estimates of ICE using the Caco-2 cell showed hydroxypheophytin a (102.53%), followed by pheophytin a' (64.69%) as the chlorophyll pigments most abundant in intestinal cells. In summary, from a nutritional perspective, these three types of the matrix (WDB, WUB, and ICE) influence the promotion of chlorophyll bioaccessibility. In this way, the data suggest that chlorophylls bioaccessibility from ICE is greater than that in WDB and WUB. Therefore, ICE should be considered a product that provides bioavailable chlorophyll and could be the best choice, such as ingredients in the development of functional foods chlorophyll-based.

Isolation of Several Indigenous Microalgae from Kallar Kahar Lake, Chakwal Pakistan

Autor: Naila Ghani

Iran J Biotechnol. 2020 Jul 1;18(3):e2214. doi: 10.30498/IJB.2020.122025.2214. eCollection 2020 Jul.

ABSTRACT

BACKGROUND: Kallar Kahar lake, Punjab, Pakistan is a rich source of phytoplankton which can be used for biofuel production.

OBJECTIVE: This study was conducted to investigate the presence of different microalgae species present in this lake and their possible utilization for bioenergy production.

MATERIALS AND METHODS: The crude culture was examined under microscope. Isolation of the identified species was carried out by using serial dilution and colony picking methods. Isolated strains were evaluated by investigating their biomass productivity, salinity resistance and auto-flocculation ability.

RESULTS: Four different microalgae species (Chlorella, Scenedesmus, Oscillatoria and Spirulina) were identified in the crude sample. The experimental results indicated that, among the four isolated strains, the Oscillatoria species showed highest biomass productivity (4.2 gL-1) and Scenedesmus showed comparatively higher salt resistance. Scenedesmus also showed great potential of auto-flocculation as around 70 % of its cells sediment within 5 h without addition of any external flocculating agent. The lipid content in the isolated strains has also been carried out using Soxhlet extraction.

CONCLUSION: Four different microalgae strains have been found in Kallar Kahar lake that reflected good biomass productivity and are capable of auto-flocculation.

Isolation of extracellular vesicles from microalgae: towards the production of sustainable and natural nanocarriers of bioactive compounds

Autor: Sabrina Picciotto

Biomater Sci. 2021 Feb 23. doi: 10.1039/d0bm01696a. Online ahead of print.

ABSTRACT

Safe, efficient and specific nano-delivery systems are essential for current and emerging therapeutics, precision medicine and other biotechnology sectors. Novel bio-based nanotechnologies have recently arisen, which are based on the exploitation of extracellular vesicles (EVs). In this context, it has become essential to identify suitable organisms or cellular types to act as reliable sources of EVs and to develop their pilot- to large-scale production. The discovery of new biosources and the optimisation of related bioprocesses for the isolation and functionalisation of nano-delivery vehicles are fundamental to further develop therapeutic and biotechnological applications. Microalgae constitute sustainable sources of bioactive compounds with a range of sectorial applications including for example the formulation of health supplements, cosmetic products or food ingredients. In this study, we demonstrate that microalgae are promising producers of EVs. By analysing the nanosized extracellular nano-objects produced by eighteen microalgal species, we identified seven promising EV-producing strains belonging to distinct lineages, suggesting that the production of EVs in microalgae is an evolutionary conserved trait. Here we report the selection process and focus on one of this seven species, the glaucophyte Cyanophora paradoxa, which returned a protein yield in the small EV fraction of 1 μg of EV proteins per mg of dry weight of microalgal biomass (corresponding to 109 particles per mg of dried biomass) and EVs with a diameter of 130 nm

(mode), as determined by the micro bicinchoninic acid assay, nanoparticle tracking and dynamic light scattering analyses. Moreover, the extracellular nanostructures isolated from the conditioned media of microalgae species returned positive immunoblot signals for some commonly used EV-biomarkers such as Alix, Enolase, HSP70, and β-actin. Overall, this work establishes a platform for the efficient production of EVs from a sustainable bioresource and highlights the potential of microalgal EVs as novel biogenic nanovehicles.

Learning Diatoms Classification from a Dry Test Slide by Holographic Microscopy

Autor: Pasquale Memmolo

Sensors (Basel). 2020 Nov 7;20(21):6353. doi: 10.3390/s20216353.

ABSTRACT

Diatoms are among the dominant phytoplankters in marine and freshwater habitats, and important biomarkers of water quality, making their identification and classification one of the current challenges for environmental monitoring. To date, taxonomy of the species populating a water column is still conducted by marine biologists on the basis of their own experience. On the other hand, deep learning is recognized as the elective technique for solving image classification problems. However, a large amount of training data is usually needed, thus requiring the synthetic enlargement of the dataset through data augmentation. In the case of microalgae, the large variety of species that populate the marine environments makes it arduous to perform an exhaustive training that considers all the possible classes. However, commercial test slides containing one diatom element per class fixed in between two glasses are available on the market. These are usually prepared by expert diatomists for taxonomy purposes, thus constituting libraries of the populations that can be found in oceans. Here we show that such test slides are very useful for training accurate deep Convolutional Neural Networks (CNNs). We demonstrate the successful classification of diatoms based on a proper CNNs ensemble and a fully augmented dataset, i.e., creation starting from one single image per class available from a commercial glass slide containing 50 fixed species in a dry setting. This approach avoids the time-consuming steps of water sampling and labeling by skilled marine biologists. To accomplish this goal, we exploit the holographic imaging modality, which permits the accessing of a quantitative phase-contrast maps and a posteriori flexible refocusing due to its intrinsic 3D imaging capability. The network model is then validated by using holographic recordings of live diatoms imaged in water samples i.e., in their natural wet environmental condition.

Lipid accumulation patterns and role of different fatty acid types towards mitigating salinity fluctuations in Chlorella vulgaris

Autor: Kit Yinn Teh

Sci Rep. 2021 Jan 11;11(1):438. doi: 10.1038/s41598-020-79950-3.

ABSTRACT

Mangrove-dwelling microalgae are well adapted to frequent encounters of salinity fluctuations across their various growth phases but are lesser studied. The current study explored the adaptive changes (in terms of biomass, oil content and fatty acid composition) of mangrove-isolated C. vulgaris UMT-M1 cultured under different salinity levels (5, 10, 15, 20, 30 ppt). The highest total oil content was recorded in cultures at 15 ppt salinity (63.5% of dry weight) with uncompromised biomass productivity, thus highlighting the 'trigger-threshold' for oil accumulation in C. vulgaris UMT-M1. Subsequently, C. vulgaris UMT-M1 was further assessed across different growth phases under 15 ppt. The various short, medium and long-chain fatty acids (particularly C20:0), coupled with a high level of C18:3n3 PUFA reported at early exponential phase represents their physiological importance during rapid cell growth. Accumulation of C18:1 and C18:2 at stationary growth phase across all salinities was seen as cells accumulating substrate for C18:3n3 should the cells anticipate a move from stationary phase into new growth phase. This study sheds some light on the possibility of 'triggered' oil accumulation with uninterrupted growth and the participation of various fatty acid types upon salinity mitigation in a mangrove-dwelling microalgae.

Microalgae-Templated Spray Drying for Hierarchical and Porous Fe(3)O(4)/C Composite Microspheres as Li-ion Battery Anode Materials

Autor: Jinseok Park

Nanomaterials (Basel). 2020 Oct 20;10(10):2074. doi: 10.3390/nano10102074.

ABSTRACT

A method of microalgae-templated spray drying to develop hierarchical porous Fe3O4/C composite microspheres as anode materials for Li-ion batteries was developed. During the spray-drying process, individual microalgae serve as building blocks of raspberry-like hollow microspheres via self-assembly. In the present study, microalgae-derived carbon matrices, naturally doped heteroatoms, and hierarchical porous structural features synergistically contributed to the high electrochemical performance of the Fe3O4/C composite microspheres, enabling a discharge capacity of 1375 mA·h·g-1 after 700 cycles at a current density of 1 A/g. Notably, the microalgal frameworks of the Fe3O4/C composite microspheres were maintained over the course of charge/discharge cycling, thus demonstrating the structural stability of the composite microspheres against pulverization. In contrast, the sample fabricated without microalgal templating showed significant capacity drops (up to ~40% of initial capacity) during the early cycles. Clearly, templating of microalgae endows anode materials with superior cycling stability.

Nutrients recycling and biomass production from Chlorella pyrenoidosa culture using anaerobic food processing wastewater in a pilot-scale tubular photobioreactor

Autor: Xiao-Bo Tan

Chemosphere. 2021 May;270:129459. doi: 10.1016/j.chemosphere.2020.129459. Epub 2020 Dec 28

ABSTRACT

Microalgae cultivation in anaerobic food wastewater was a feasible way for high biomass production and nutrients recycling. In this study, Chlorella pyrenoidosa culture on anaerobic food wastewater was processed outdoors using a pilot-scale tubular photobioreactor. The microalgae showed rapid growth in different seasons, achieving high biomass production of 1.83-2.10 g L-1 and specific growth rate of 0.73-1.59 d-1. The biological contamination and dissolved oxygen were controlled at suitable levels for algal growth in the tubular photobioreactor. Lipids content in harvested biomass was 8.1-15.3% of dried weight, and the analysis in fatty acids revealed high quality with long carbon chain length and high saturation. Additionally, algal growth achieved effective pollutants purification from wastewater, removing 42.3-53.8% of CODCr, 82.6-88.7% of TN and 59.7-67.6% of TP. This study gave a successful application for scaled-up microalgae culture in anaerobic food processing wastewater for biodiesel production and wastewater purification.

OPTIMIZATION OF A NEW CULTURE MEDIUM FOR THE LARGE-SCALE PRODUCTION OF PROTEIN-RICH ARTHROSPIRA PLATENSIS (OSCILLATORIALES, CYANOPHYCEAE)

Autor: Cintia Gómez

J Phycol. 2020 Nov 29. doi: 10.1111/jpy.13111. Online ahead of print.

ABSTRACT

Our aim was to develop a novel medium for the large-scale production of protein-rich Arthrospira with potential applications as a biofertilizer. The novel culture medium, termed as FM-II, was formulated using low-cost commercial chemicals and specifically designed to improve protein production. Both Arthrospira platensis and Arthrospira maxima were produced using FM-II and Arnon medium, which was used as a control. Photosynthetic status of the cells, which was checked by measuring chlorophyll fluorescence, biomass dry weight and protein content, was assessed daily. Arthrospira platensis had higher biomass and protein productivities than A. maxima when cultured in both control and FM-II media. Incorporation of varied micronutrients into FM-II formulation did not improve biomass productivity. Maximum biomass dry weight in FM-II and control medium was 2.9 and 2.5 g · L-1 , respectively. Total protein content of the biomass ranged between 55% and 65%, suggesting potential for being used in the development of high-value agricultural products. As some nutrients were discarded unused, the initial content of phosphates and bicarbonates was reduced by 75% and 50%, respectively, without affecting the process productivity. Results reported herein could promote the production and utilization of Arthrospira platensis by significantly reducing productions costs and therefore increasing the feasibility of the process.

Photoautotrophic production of eicosapentaenoic acid

Autor: Wenjia Gu

Crit Rev Biotechnol. 2021 Mar 30:1-18. doi: 10.1080/07388551.2021.1888065. Online ahead of print.

ABSTRACT

Eicosapentaenoic acid (EPA) is an omega-3 fatty acid which is an essential nutrient for both humans and animals. This review examines the global need for EPA, both in human nutrition and aquaculture. The potential shortfall in supply of this important nutrient as well as sustainability issues with wild-caught fish have generated increased interest into alternative sources of EPA. Various approaches are summarized, including heterotrophic production and the use of genetically modified microorganisms and plants. Studies on photoautotrophic production of EPA are extensively reviewed. Widely used species for large-scale production of EPA includes Phaeodactylum tricornutum and Nannochloropsis due to their robustness and relatively high growth rates and EPA content (typically 5% of dry biomass). Approaches for large-scale production have also been reviewed. Closed reactors like flat panels, tubular reactors and bubble columns may be the most suitable due to their high productivity. However, there is no agreement in the literature as to which design generates the lowest cost of production. The economics of the process has also been examined. The best estimates for large-scale (100 hectare) plants give EPA prices of the order 39-90 USD per kilogram. This is approximately ten times higher than the price of EPA derived from fish oil. Potential avenues for lowering the cost are highlighted, along with the need to better understand the advantages and disadvantages of different EPA production methods from a more holistic perspective.

Phytohormone release by three isolated lichen mycobionts and the effects of indole-3-acetic acid on their compatible photobionts

Autor: Gregor Pichler

Symbiosis. 2020;82(1):95-108. doi: 10.1007/s13199-020-00721-9. Epub 2020 Oct 22.

ABSTRACT

Evidence is emerging that phytohormones represent key inter-kingdom signalling compounds supporting chemical communication between plants, fungi and bacteria. The roles of phytohormones for the lichen symbiosis are poorly understood, particularly in the process of lichenization, i.e. the key events which lead free-living microalgae and fungi to recognize each other, make physical contact and start developing a lichen thallus. Here, we studied cellular and extracellularly released phytohormones in three lichen mycobionts, Cladonia grayi, Xanthoria parietina and Tephromela atra, grown on solid medium, and the effects of indole-3-acetic acid (IAA) on their respective photobionts, Asterochloris glomerata, Trebouxia decolorans, Trebouxia sp. Using ultra-high-performance liquid chromatography coupled with tandem mass spectrometry (UHPLC-MS/MS) we found that mycobionts produced IAA, salicylic acid (SA) and jasmonic acid (JA). IAA represented the most abundant phytohormone produced and released

by all mycobionts, whereas SA was released by X. parietina and T. atra, and JA was released by C. grayi only. With a half-life of 5.2 days, IAA degraded exponentially in solid BBM in dim light. When IAA was exogenously offered to the mycobionts' compatible photobionts at "physiological" concentrations (as released by their respective mycobionts and accumulated in the medium over seven days), the photobionts' water contents increased up to 4.4%. Treatment with IAA had no effects on the maximum quantum yield of photosystem II, dry mass, and the contents of photosynthetic pigments and α-tocopherol of the photobionts. The data presented may be useful for designing studies aimed at elucidating the roles of phytohormones in lichens.

Prostaglandin production by the microalga with heterologous expression of cyclooxygenase

Autor: Yoshiaki Maeda

Biotechnol Bioeng. 2021 Apr 14. doi: 10.1002/bit.27792. Online ahead of print.

ABSTRACT

Prostaglandins (PGs) are the physiologically active compounds synthesized from C20 polyunsaturated fatty acids (PUFAs) by cyclooxygenase (COX) and a series of PG synthases, and are utilized as pharmaceuticals. Currently, commercialized PGs are mainly produced by chemical synthesis under harsh conditions. By contrast, bioproduction of PGs can be an alternative, environmental-friendly, and inexpensive process with genetic engineering of model plants, although these conventional host organisms contain a limited quantity of PG precursors. In this study, we established an efficient PG production process using the genetically engineered microalga Fistulifera solaris which is rich in C20 PUFAs. A cox gene derived from the red alga Agarophyton vermiculophyllum was introduced into F. solaris. As a result, a transformant clone with high cox expression produced PGs (i.e., PGD2 , PGE2 , PGF2α , and 15-ketoPGF2α derived from arachidonic acid, and PGD3 , PGE3 , and PGF3α derived from eicosapentaenoic acid) as revealed by liquid chromatography/mass spectrometry. The total content of PGs was 1290.4 ng/g of dry cell weight, which was higher than that produced in the transgenic plant reported previously. The results obtained in this study indicate that the C20 PUFA-rich microalga functionally expressing COX is a promising host for PG bioproduction.

Rapid Changes in the Phytoplankton Community of a Subtropical, Shallow, Hypereutrophic Lake During the Rainy Season

Autor: Osiris Díaz-Torres

Front Microbiol. 2021 Mar 9;12:617151. doi: 10.3389/fmicb.2021.617151. eCollection 2021.

ABSTRACT

Lake Cajititlán is a small, shallow, subtropical lake located in an endorheic basin in western Mexico. It is characterized by a strong seasonality of climate with pronounced wet and dry seasons and has been classified as a hypereutrophic lake. This eutrophication was driven by improperly treated sewage discharges from four municipal wastewater treatment plants

(WWTPs) and by excessive agricultural activities, including the overuse of fertilizers that reach the lake through surface runoff during the rainy season. This nutrient rich runoff has caused algal blooms, which have led to anoxic or hypoxic conditions, resulting in large-scale fish deaths that have occurred during or immediately after the rainy season. This study investigated the changes in the phytoplankton community in Lake Cajititlán during the rainy season and the association between these changes and the physicochemical water quality and environmental parameters measured in the lake's basin. Planktothrix and Cylindrospermopsis were the dominant genera of the cyanobacterial community, while the Chlorophyceae, Chrysophyceae, and Trebouxiophyceae classes dominated the microalgae community. However, the results showed a significant temporal shift in the phytoplankton communities in Lake Cajititlán induced by the rainy season. The findings of this study suggest that significant climatic variations cause high seasonal surface runoff and rapid changes in the water quality (Chlorophyll-a, DO, NH4 +, and NO3 -) and in variations in the composition of the phytoplankton community. Finally, an alternation between phosphorus and nitrogen limitation was observed in Lake Cajititlán during the rainy season, clearly correlating to the presence of Planktothrix when the lake was limited by phosphorus and to the presence of Cylindrospermopsis when the lake was limited by nitrogen. The evidence presented in this study supports the idea that the death of fish in Lake Cajititlán could be mainly caused by anoxia, caused by rapid changes in water quality during the rainy season. Based on our review of the literature, this is the first study on the phytoplankton community in a subtropical lake during the rainy season using high throughput 16S rRNA and 18S rRNA amplicon sequencing.

Recent Advances in Microalgal Bioactives for Food, Feed, and Healthcare Products: Commercial Potential, Market Space, and Sustainability

Autor: Nethravathy M U

Compr Rev Food Sci Food Saf. 2019 Nov;18(6):1882-1897. doi: 10.1111/1541-4337.12500. Epub 2019 Oct 15.

ABSTRACT

To combat food scarcity as well as to ensure nutritional food supply for sustainable living of increasing population, microalgae are considered as innovative sources for adequate nutrition. Currently, the dried biomass, various carotenoids, phycocyanin, phycoerythrin, omega fatty acids, and enzymes are being used as food additives, food coloring agents, and food supplements. Apart from nutritional importance, microalgae are finding the place in the market as "functional foods." When compared to the total market size of food and feed products derived from all the possible sources, the market portfolio of microalgae-based products is still smaller, but increasing steadily. On the other hand, the genetic modification of microalgae for enhanced production of commercially important metabolites holds a great potential. However, the success of commercial application of genetically modified (GM) algae will be defined by their safety to human health and environment. In view of this, the present study attempts to highlight the industrially important microalgal metabolites, their production, and application in food, feed, nutraceuticals, pharmaceuticals, and cosmeceuticals. The current and future market trends for microalgal products have been thoroughly discussed. Importantly, the safety pertaining to microalgae cultivation and consumption, and regulatory issues for GM microalgae have also been covered.

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

Autor: Sivagnanam Silambarasan

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

ABSTRACT

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

Removal of sugars in wastewater from food production through heterotrophic growth of Galdieria sulphuraria

Autor: Philipp Scherhag

Eng Life Sci. 2020 Dec 21;21(3-4):233-241. doi: 10.1002/elsc.202000075. eCollection 2021 Mar.

ABSTRACT

The unicellular extremophilic red alga Galdieria sulphuraria is capable of chemoheterotrophy and its growth has been investigated on some defined and undefined substrates. In this study, the removal of sugars in wastewater from fruit-salad production with G. sulphuraria strain SAG 21.92 was analyzed. Growth and sugar consumption were determined under variation of temperature, pH-value and concentration of a model substrate, containing sucrose, glucose and fructose. In shake flask cultivation maximum specific growth rate and specific substrate consumption rate of 1.53±0.09 day-1 and 2.41±0.14 gSub·gDW -1·day-1 were measured at pH 2 and 42°C. A scale-up of this process was conducted in a 3 L stirred tank reactor (STR). Wastewater from fruit-salad production was diluted to 15 g·L-1 total sugar concentration,

supplemented with micronutrients and ammonia and pH was set to 3. Determined growth rate and substrate consumption were 1.21 day-1 and 1.88 gSub·gDW -1·day-1, respectively. It was demonstrated, that high sugar concentrations in wastewater streams from food production processes can be significantly reduced with G. sulphuraria SAG 21.92. This strain could achieve substrate consumption rates in wastewater, equal to the more common strain 074G, but at higher pH values. Generated biomass can be used for production of phycocyanin, a valuable nutraceutical

Solar-Powered Carbon Fixation for Food and Feed Production Using Microorganisms-A Comparative Techno-Economic Analysis

Autor: Marja Nappa

ACS Omega. 2020 Dec 17;5(51):33242-33252. doi: 10.1021/acsomega.0c04926. eCollection 2020 Dec 29.

ABSTRACT

This study evaluates the techno-economic feasibility of five solar-powered concepts for the production of autotrophic microorganisms for food and feed production; the main focus is on three concepts based on hydrogen-oxidizing bacteria (HOB), which are further compared to two microalgae-related concepts. Two locations with markedly different solar conditions are considered (Finland and Morocco), in which Morocco was found to be the most economically competitive for the cultivation of microalgae in open ponds and closed systems (1.4 and 1.9 € kg-1, respectively). Biomass production by combined water electrolysis and HOB cultivation results in higher costs for all three considered concepts. Among these, the lowest production cost of 5.3 € kg-1 is associated with grid-assisted electricity use in Finland, while the highest production cost of >9.1 € kg-1 is determined for concepts using solely photovoltaics and/or photoelectrochemical technology for on-site electricity production and solar-energy conversion to H2 by water electrolysis. All assessed concepts are capital intensive. Furthermore, a sensitivity analysis suggests that the production costs of HOB biomass can be lowered down to 2.1 € kg-1 by optimization of the process parameters among which volumetric productivity, electricity strategy, and electricity costs have the highest cost-saving potentials. The study reveals that continuously available electricity and H2 supply are essential for the development of a viable HOB concept due to the capital intensity of the needed technologies. In addition, volumetric productivity is the key parameter that needs to be optimized to increase the economic competitiveness of HOB production.

Surface modifying amphiphilic additives and their effect on the fouling-release performance of siloxane-polyurethane coatings

Autor: Jackson Benda

Biofouling. 2021 Mar 24:1-18. doi: 10.1080/08927014.2021.1901891. Online ahead of print.

ABSTRACT

In this work, surface-modifying amphiphilic additives (SMAAs) were synthesized via hydrosilylation using various polymethylhydrosiloxanes (PMHS) and allyl-terminated polyethylene glycol monomethyl ethers (APEG) of varying molecular weights. The additives synthesized were incorporated into a hydrophobic, self-stratifying siloxane-polyurethane (SiPU) coating system to produce an amphiphilic surface. Contact angle experiments and atomic force microscopy (AFM), in a dry and hydrated state, were performed to assess changes in surface wettability and morphology. The antifouling and fouling-release (AF/FR) performances were evaluated by performing laboratory biological assays using the marine bacterium Cellulophaga lytica, the microalga Navicula incerta, the macroalga Ulva linza, the barnacle Amphibalanus amphitrite, and the marine mussel, Geukensia demissa. Several of the formulations showed improved AF/FR performance vs the base SiPU and performed better than some of the commercial standard marine coatings. Formulations containing SMAAs with a low grafting density of relatively high molecular weight PEG chains showed the best performance overall

Sustainable development of microalgal biotechnology in coastal zone for aquaculture and food

Autor: Xiangning Lu

Sci Total Environ. 2021 Mar 10;780:146369. doi: 10.1016/j.scitotenv.2021.146369. Online ahead of print.

ABSTRACT

Region-specific Research and Development (R&D) of microalga-derived product systems are crucial if "biotech's green gold" is to be explored in a rational and economically viable way. Coastal zones, particularly the locations around the equator, are typically considered to be optimum cultivation sites due to stable annual temperature, light, and ready availability of seawater. However, a 'cradle-to-grave' assessment of the development of microalgal biotechnology in these areas, not only under the laboratory conditions, but also in the fields has not yet been demonstrated. In this study, to evaluate the viability of microalga-derived multi-product technology, we showed the development of microalgal biotechnology in coastal zones for aquaculture and food. By creating and screening a (sub)tropical microalgal collection, a Chlorella strain MEM25 with a robust growth in a wide range of salinities, temperatures, and light intensities was identified. Evaluation of the economic viability and performance of different scale cultivation system designs (500 L and 5000 L closed photobioreactors and 60,000 L open race ponds, ORPs) at coastal zones under geographically specific conditions showed the stable and robust characteristics of MEM25 across different production system designs and various spatial and temporal scales. It produces high amounts of proteins and polyunsaturated fatty acids (PUFAs) in various conditions. Feeding experiments reveal the nutritional merits of MEM25 as food additives where PUFAs and essential amino acids are enriched and the algal diet improves consumers' growth. Economic evaluation highlights an appreciable profitability of MEM25 production as human or animal food using ORP systems. Therefore, despite the pros and cons, sound opportunities exist for the development of market-ready multiple-product systems by employing region-specific R&D strategies for microalgal biotechnology.

Techno-economics of algae production in the Arabian Peninsula

Autor: Kira Schipper

Bioresour Technol. 2021 Jul;331:125043. doi: 10.1016/j.biortech.2021.125043. Epub 2021 Mar 26.

ABSTRACT

The Arabian Peninsula's advantageous climate, availability of non-arable land, access to seawater and CO2-rich flue gas, make it an attractive location for microalgae biomass production. Despite these promising aspects, the region has seen very few studies into the commercial feasibility of algae-based value chains. This work aims to address this gap through a techno-economic feasibility study of algae biomass production costs, comparing different photobioreactor types, locations, and production scales. Flat panel and raceway pond cultivation systems were found to be the most economically attractive cultivation systems, with biomass production costs as low as 2.9 €·kg-1. Potential cost reductions of up to 42.5% and 25% could be accomplished with improvements in photosynthetic efficiencies and increased culture temperatures, respectively. As of such, efforts to source local thermo- and photo- tolerant strains could be the key to unlock the potential of the region for algae commercialization, linking into food, feed and nutraceutical industries

The Contribution Ratio of Autotrophic and Heterotrophic Metabolism during a Mixotrophic Culture of Chlorella sorokiniana

Autor: Jeong-Eun Park

Int J Environ Res Public Health. 2021 Feb 2;18(3):1353. doi: 10.3390/ijerph18031353.

ABSTRACT

The contribution ratio of autotrophic and heterotrophic metabolism in the mixotrophic culture of Chlorella sorokiniana (C. sorokiniana) was investigated. At the early stage of mixotrophic growth (day 0-1), autotrophy contributed over 70% of the total metabolism; however, heterotrophy contributed more than autotrophy after day 1 due to the rapid increase in cell density, which had a shading effect in the photo-bioreactor. Heterotrophy continued to have a higher contribution until the available organic carbon was depleted at which point autotrophy became dominant again. Overall, the increase in algal biomass and light conditions in the photo-bioreactor are important factors in determining the contribution of autotrophy and heterotrophy during a mixotrophic culture.

The Influence of Bacteria on the Growth, Lipid Production, and Extracellular Metabolite Accumulation by Phaeodactylum tricornutum (Bacillariophyceae)

Autor: Adam M Chorazyczewski

J Phycol. 2021 Jan 17. doi: 10.1111/jpy.13132. Online ahead of print.

ABSTRACT

To examine the impact of heterotrophic bacteria on microalgal physiology, we co-cultured the diatom Phaeodactylum tricornutum with six bacterial strains to quantify bacteria-mediated differences in algal biomass, total intracellular lipids, and for a subset, extracellular metabolite accumulation. A Marinobacter isolate significantly increased algal cell concentrations, dry biomass, and lipid content compared to axenic algal cultures. Two other bacterial strains from the Bacteroidetes order, of the genera Algoriphagus and Muricauda, significantly lowered P. tricornutum biomass, leading to overall decreased lipid accumulation. These three bacterial co-cultures (one mutualistic, two competitive) were analyzed for extracellular metabolites via untargeted liquid chromatography mass spectrometry to compare against bacteria-free cultures. Over 80% of the extracellular metabolites differentially abundant in at least one treatment were in higher concentrations in the axenic cultures, in agreement with the hypothesis that the co-cultured bacteria incorporated algal-derived organic compounds for growth. Furthermore, the extracellular metabolite profiles of the two growth-inhibiting cultures were more similar to one another than the growth-promoting co-culture, linking metabolite patterns to ecological role. Our results show that algal-bacterial interactions can influence the accumulation of intracellular lipids and extracellular metabolites, and suggest that utilization and accumulation of compounds outside the cell play a role in regulating microbial interactions.

The carbon partitioning of glucose and DIC in mixotrophic, heterotrophic and photoautotrophic cultures of Tetraselmis suecica

Autor: J K Penhaul Smith

Biotechnol Lett. 2021 Mar;43(3):729-743. doi: 10.1007/s10529-020-03073-y. Epub 2021 Jan 18.

ABSTRACT

OBJECTIVE: Changes in the partitioning of dissolved inorganic (DIC) and glucose were elucidated by utilising 13C labelled DIC or glucose, and quantifying the biochemical profile of mixotrophic, heterotrophic and photoautotrophic cultures of the microalga Tetraselmis suecica.

RESULTS: Mixotrophic cultivation increases microalgal productivity and changes their biochemical profile, due to an alteration in the partitioning of carbon within the cell. When cultured mixotrophically and heterotrophically, there is enhanced incorporation of carbon into shorter chain saturated fatty acids and non-lipid biomass, compared to photoautotrophic cultivation. Autotrophic culture results in increased total fatty acid content of cultures (4.19% dry weight compared to 2.13%) and shifts the fatty acid profile in favour of long-chain unsaturated fatty acids, such as 18:2 n-(9,12), compared to mixotrophic culture. Quantifying the changes in partitioning between DIC and glucose facilitates tailoring of the biochemical profile to develop "designer" algae.

CONCLUSIONS: There is a condition specific shift in carbon partitioning into different fatty acid and biochemical fractions in T. suecica, with more inorganic carbon partitioned into 18:2 n-(9,12) in photoautotrophic rather than mixotrophic cultures.

The impact of abiotic factors on the growth and lipid accumulation of some green microalgae for sustainable biodiesel production

Autor: Mustafa A Fawzy

Environ Sci Pollut Res Int. 2021 Apr 4. doi: 10.1007/s11356-021-13781-1. Online ahead of print.

ABSTRACT

Three species of freshwater planktonic green microalgae: Ankistrodesmus braunii, Ankistrodesmus falcatus, and Scenedesmus incrassatulus, were isolated from the Nile water in Upper Egypt. These microalgae were exposed to nutritional (nitrogen, phosphorus, and iron) limitations and salinity stress to study their effects on the algal growth and to elevate the lipid content within their cells. The results indicated that exposure to these conditions had a significant impact on the algal growth. The lipid content of the studied algae increased as a result of the salinity stress. The highest lipid content was recorded in A. braunii culture treated with 50 mM NaCl (34.4% of dry weight) and S. incrassatulus cultures treated with 100 mM NaCl (37.7% of dry weight) on the 6th day of cultivation, while the culture of A. falcatus treated with 100 mM NaCl recorded the maximum lipid content (53% of dry weight) on the 10th day of the experiment. The biodiesel quality parameters of the fatty acid methyl ester profile of S. incrassatulus appeared to be in agreement with the international criteria. S. incrassatulus could be regarded as a quite promising feedstock for the biodiesel production.

The maximum growth rate hypothesis is correct for eukaryotic photosynthetic organisms, but not cyanobacteria

Autor: T A V Rees

New Phytol. 2021 Jan 15. doi: 10.1111/nph.17190. Online ahead of print.

ABSTRACT

The (maximum) growth rate (μmax) hypothesis predicts that cellular and tissue phosphorus (P) concentrations should increase with increasing growth rate, and RNA should also increase as most of the P is required to make ribosomes. Using published data, we show that though there is a strong positive relationship between the μmax of all photosynthetic organisms and their P content (% dry weight), leading to a relatively constant P productivity, the relationship with RNA content is more complex. In eukaryotes there is a strong positive relationship between μmax and RNA content expressed as % dry weight, and RNA constitutes a relatively constant 25% of total P. In prokaryotes the rRNA operon copy number is the important determinant of the amount of RNA present in the cell. The amount of phospholipid expressed as % dry weight increases with increasing μmax in microalgae. The relative proportions of each of the five major P-containing constituents is remarkably constant, except that the proportion of RNA is greater and phospholipids smaller in prokaryotic than eukaryotic photosynthetic organisms. The effect of temperature differences between studies was minor. The evidence for and against P-

containing constituents other than RNA being involved with ribosome synthesis and functioning is discussed.

Towards high-quality biodiesel production from microalgae using original and anaerobically-digested livestock wastewater

Autor: Gang Li

Chemosphere. 2020 Oct 9:128578. doi: 10.1016/j.chemosphere.2020.128578. Online ahead of print.

ABSTRACT

In this study, we conducted proof-of-concept research towards the simultaneous treatment of livestock wastewater and the generation of high-quality biodiesel, through microalgae technology. Both original (OPE) and anaerobically-digested (DPE) piggery effluents were investigated for the culture of the microalgae, Desmodesmus sp. EJ8-10. After 14 days' cultivation, the dry biomass from microalgae cultivated in OPE increased from an initial value of 0.01 g/L to 0.33-0.39 g/L, while those growing in DPE only achieved a final dried mass of 0.15-0.35 g/L, under similar initial ammonium nitrogen (NH4+-N) concentrations. The significantly higher microalgal biomass production achieved in the OPE medium may have been supported by the abundance of both macronutrient, such as phosphorus (P), and of micronutrients, such as trace elements, present in the OPE, which may not been present in similar quantities in the DPE. However, a higher lipid content was observed (19.4-28%) in microalgal cells from DPE cultures than those (18.7-22.3%) from OPE cultures. Moreover, the fatty acid compositions in the microalgae cultured in DPE contained high levels of monounsaturated fatty acids (MUFAs) and total C16-C18 acids, which would afford a superior potential for high-quality biodiesel production. The N/P ratio (15.4:1) in OPE was much closer to that indicated by previous studies to be the most suitable (16:1) for microalgae growth, when compared with that determined from the DPE culture medium. This may facilitate protein synthesis in the algal cells and induce a lower accumulation of lipids. Based on these findings, we proposed a new flowsheet for sustainable livestock waste management.

Two Benthic Diatoms, Nanofrustulum shiloi and Striatella unipunctata, Encapsulated in Alginate Beads, Influence the Reproductive Efficiency of Paracentrotus lividus by Modulating the Gene Expression

Autor: Francesca Glaviano

Mar Drugs. 2021 Apr 17;19(4):230. doi: 10.3390/md19040230.

ABSTRACT

Physiological effects of algal metabolites is a key step for the isolation of interesting bioactive compounds. Invertebrate grazers may be fed on live diatoms or dried, pelletized, and added to compound feeds. Any method may reveal some shortcomings, due to the leaking of wound-

activated compounds in the water prior to ingestion. For this reason, encapsulation may represent an important step of bioassay-guided fractionation, because it may assure timely preservation of the active compounds. Here we test the effects of the inclusion in alginate (biocompatible and non-toxic delivery system) matrices to produce beads containing two benthic diatoms for sea urchin Paracentrotus lividus feeding. In particular, we compared the effects of a diatom whose influence on P. lividus was known (Nanofrustulum shiloi) and those of a diatom suspected to be harmful to marine invertebrates, because it is often present in blooms (Striatella unipunctata). Dried N. shiloi and S. unipunctata were offered for one month after encapsulation in alginate hydrogel beads and the larvae produced by sea urchins were checked for viability and malformations. The results indicated that N. shiloi, already known for its toxigenic effects on sea urchin larvae, fully conserved its activity after inclusion in alginate beads. On the whole, benthic diatoms affected the embryogenesis of P. lividus, altering the expression of several genes involved in stress response, development, skeletogenesis and detoxification processes. Interactomic analysis suggested that both diatoms activated a similar stress response pathway, through the up-regulation of hsp60, hsp70, NF-κB, 14-3-3 ε and MDR1 genes. This research also demonstrates that the inclusion in alginate beads may represent a feasible technique to isolate diatom-derived bioactive compounds.

Unexpected acceleration of Ultrasonic-Assisted iodide dosimetry in the catalytic presence of ionic liquids

Autor: Sooridarsan Krishnan

Ultrason Sonochem. 2021 Apr 25;74:105576. doi: 10.1016/j.ultsonch.2021.105576. Online ahead of print.

ABSTRACT

This study investigates the potential of using small amounts of ionic liquids (IL) to enhance ultrasound-assisted extraction of lipids content from green microalgae. Three imidazolium-based ILs (butyl, octyl and dodecyl), each of them with two anions (bromide and acetate) were tested as additives. Viscosity and surface tension of the ILs aqueous mixtures were analyzed to determine the influence of ILs' anions and alkyl chain length, whereas KI dosimetry experiments were used as an indicator of radicals formation. A key finding suggests that the small addition of ILs improves the ultrasonication either by enhancing the viscosity and reducing the water surface tension, leading to a more powerful acoustic cavitation process or by increasing HO° production likely to oxidize the microalgae cells membranes, and consequently disrupting them on a more efficient manner. KI dosimetry also revealed that long ILs alkyl chain is detrimental. This experimental observation is confirmed thus strengthened as the yield of extracted lipids from green microalgae has shown an incremental trend when the IL concentration also increased. These hypotheses are currently under investigation to spot detailed impact of ILs on cavitation process.

PATENTES

ALGAE THERMOPLASTIC COMPOSITION AND PROCESS OF MAKING

Inventor(s): ZELLER MARK ASHTON [US]; HUNT RYAN [US] +

Applicant(s): ALGIX LLC [US] +

An algae-based thermoplastic foam is provided having a protein-rich algae biomass selected from either microalgae, macroalgae or combinations thereof. The protein content is greater than or equal to 15% by weight of the algae biomass and the algae biomass is dried to a moister content of less than or equal to 15% by weight having an average particle size of up to 200 microns. The composition includes a resin configured to exhibit rheological properties suitable for blending with algae including a melting temperature less than 250° C. and a melt flow rate in excess of 0.01 g/10 min. The foam includes a foaming ingredient selected from the group consisting of crosslinkers, compatibilizers, plasticizers, accelerants, catalysts, blowing agents, other ingredients, and combinations thereof.

Biomass hydrothermal capacity process and device

Inventor(s): ZHOU WENGUANG; CHEN JIE; LENG LIJIAN; YAN YUPING; WEI FENG; LI JUN; LI JINGJING; HUANG JIAXIN +

Applicant(s): UNIV NANCHANG +

The invention relates to a biomass hydrothermal capacity process and device. The process specifically comprises the following steps: diluting hydrothermal water-phase wastewater, inoculating fungi forculture, harvesting microalgae, carrying out hydrothermal capacity on algal bacteria biomass, recycling purified water and carrying out cyclic capacity, thereby forming the biomass hydrothermal capacity process in a semi-closed cyclic mode. The device comprises a fungus and microalgae bioreactor, a filter, a hydrothermal reaction kettle, a gas storage bottle, a carbon storage bottle, an oil storage bottle, a mixed gas chamber, a light source, a CO2 gas tank and the like. The invention provides a method for jointly recovering nutrient elements of hydrothermal water-phase wastewater and recycling water resources by filamentous fungi and microalgae for the first time, establishes a biomass semi-closed cycle energy production device based on a hydrothermal process, and the device integrates biomass conversion, hydrothermal water-phase wastewater treatment, water resource recovery, microalgae culture and algal bacteria recovery into a whole, the cost of the whole capacity process is reduced, the investment of microalgae culture and algal bacteria harvesting is particularly reduced, and a new thought is provided for industrial application of a biomass refining system.

Method for extracting microalgae intracellular metabolite by composite solvent and water stimulation method

Inventor(s): REN XIAOJIE; ZHAO XINHE; SONG YUANDA +

Applicant(s): UNIV SHANDONG TECHNOLOGY +

The invention provides a method for carrying out cell membrane dissolution and metabolite product extraction on microalgae by using a composite solvent and water stimulation process by taking the microalgae as an object. The method comprises the following steps: step 1, taking wet algae mud as a raw material, preliminarily destroying algae cell membranes through a chloroform and methanol mixed solvent, and extracting metabolites; 2, adding deionized water into the extracted algae cells, and promoting cell membrane disintegration, and 3, extracting intracellular metabolites by using the mixed solvent chloroform and methanol again, combining the chloroform and methanol solutions obtained by two times of extraction, adding a sodium chloride solution, and carrying out centrifugal layering. Phosphosaccharides such as fructose hexaphosphate and glucose hexaphosphate, organic acids such as pyruvic acid and malic acid, energy substances such as ATP and ADP, and reducing power substances such as NA (D) P enter a methanol phase. Cytochrome, fatty acid and the like enter a chloroform phase. According to the method, the metabolite dissolution rate is high, multiple metabolites can be extractedat the same time, and the metabolite oxidative denaturation problem caused in the cell drying process is greatly reduced.

Method for increasing content of aldol phospholipid in microalgae and RNA interference fragment

Inventor(s): HU HANHUA; PAN YUFANG +

Applicant(s): INST OF HYDROBIOLOGY CAS +

The invention relates to a method for increasing the content of acetal phospholipid in microalgae. The method comprises the following steps: down-regulating expression of phospholipid: diglyceride acyltransferase in the microalgae; the invention also relates to an RNA interference fragment capable of improving the acetal phospholipid content in nannochloropsis oculata, the RNA interference fragment comprises a pair of reverse repeat regions, and the sequence of the reverse repeat regions is homologous with the mRNA sequence of the nPDAT gene; the invention also relates to an expression vectorof the RNA interference fragment. The nannochloropsis oculata is subjected to genetic modification, expression of the nPDAT gene in the nannochloropsis oculata is reduced, the acetal phospholipid content in the nannochloropsis oculata is greatly increased to about 150 nmol/g from about 50 nmol/g dry weight, culture conditions are optimized in the culture process, the acetal phospholipid content isfurther increased by about 360 nmol/g, and a possible way is provided for commercialized production of acetal phospholipids by using microalgae.

Method for preparing D-psicose from microalgae

Inventor(s): CHEN XIAOYAN; YU QIANG; ZHANG YU; YUAN ZHENHONG; WANG ZHONGMING +

Applicant(s): GUANGZHOU INST ENERGY CONVERSION CAS

The invention provides a method for preparing D-psicose from microalgae. The method comprises the following steps: performing enzymolysis saccharification on a dry microalgae substance with cellulaseto obtain a microalgae enzymolysis liquid, meanwhile, constructing an Escherichia coli recombinant strain capable of realizing biotransformation of D-psicose, carrying out isomerization transformationon the microalgae enzymolysis liquid by using the recombinant strain, and conducting spectrum separation treatment on a product to finally obtain the D-psicose with purity of 95%. The D-psicose is prepared with microalgae as raw materials, the production cost of the D-psicose can be effectively reduced, and the method has positive significance in accelerating the industrialization process.

Microalgae culture and algae cake harvesting integrated equipment and method

Inventor(s): ZHOU XU; MAO YUFENG; XI JINGJING; TU RENJIE +

Applicant(s): HARBIN INSTITUTE OF TECH SHENZHEN SHENZHEN INSTITUTE OF SCIENCE AND TECH INNOVATION HARBIN INSTITUTE +

The invention provides microalgae culture and algae cake harvesting integrated equipment and method. The equipment comprises a raceway pond, a water pump, a dosing box, a reaction precipitation tank,a diaphragm pump and a plate-and-frame filter press, wherein the raceway pond, the water pump, the reaction precipitation tank, the diaphragm pump and the plate-and-frame filter press are sequentiallyconnected; and the dosing box is connected with the water pump. The beneficial effects of the method are as follows: 1, the method combines two traditional processes of microalgae culture and microalgae harvesting, and has the advantages of high efficiency, low cost, low energy consumption, no pollution, no need of secondary installation of industrial equipment and the like; 2, a microalgae culture and harvest integrated technology which is high in efficiency, low in cost and low in energy consumption and can realize industrial application is constructed, microalgae can be quickly settled under the flocculation action of a flocculant and the gravity action of the microalgae, the microalgae flocculation efficiency is up to 90% or above, algae cakes with the water content of about 40% can be obtained after passing through a plate-and-frame filter press, and the microalgae culture and harvest integrated equipment and method have a good industrialization prospect.

Microalgae culture method for determining nitrogen supply torsion night grease loss based on photoperiod

Inventor(s): QI FENG; MU RUIMIN; MA GUIXIA; JIA YANTIAN; LIU LERAN; HAO KAIXUAN +

Applicant(s): UNIV SHANDONG JIANZHU +

A microalgae culture method for determining nitrogen supply torsion night grease loss based on a photoperiod comprises the following steps: (1) accumulation of microalgae biomass: inoculating sterileoil-producing microalgae species into a photobioreactor, performing microalgae nitrogen-enriched culture under outdoor natural illumination conditions according to a biomass growth priority mode, introducing CO2-enriched air in the culture process till the microalgae reach a stable growth period; (2) accumulating microalgae grease and harvesting algae liquid: under an outdoor natural illuminationcondition, introducing CO2-rich air for culture, achieving conversion of nitrogen-rich and anoxic environments along with an illumination period by switching a nitrogen supply mode, and replacing thealgae liquid everyday according to a proportion; and (3) separating and drying the replaced algae liquid to obtain algae powder extracted grease, thereby obtaining biodiesel. According to the invention, the nitrogen nutrient supply amount is controlled through the photoperiod, so that the nitrogen nutrient concentration in the culture environment and the photoperiod are synchronously regulated andcontrolled, and the net accumulation of grease at night is achieved, thereby improving the overall grease yield of microalgae.

Microalgae harvesting and liquid spraying extraction integrated system

Inventor(s): WU HUAIZHI; LYU XUEFENG; DUAN YANGKAI; ZHANG KAI; LIU XIANG; LI XIN +

Applicant(s): QINGDAO INST BIOENERGY & BIOPROCESS TECH CAS +

The utility model relates to the field of microalgae harvesting. The utility model relates to a microalgae harvesting system, in particular to a microalgae harvesting and liquid spraying extraction integrated system. The device comprises a harvesting bed, a harvesting and purging system, an algae mud uniform distributor, an extracting solution nozzle, a microalgae extracting bed and a purging assembly, filter cloth and a filter screen pore plate are arranged in the harvesting bed; the filter screen pore plate is obliquely arranged in the harvesting bed; the filter cloth is arranged on the filter screen pore plate; the harvesting and purging system is arranged above the filter cloth; an algae liquid distribution pipe is arranged above the high-side input end of the filter screen pore plate;an algae mud temporary storage box is arranged at the output end of the lower side of the filter screen pore plate; wherein the algae mud uniform distributor and the microalgae extraction bed are arranged on the output side of the harvesting bed, the algae mud uniform distributor and the purging assembly are arranged above the microalgae extraction bed, the algae mud temporary storage box is arranged above the input end of the algae mud uniform distributor, an extraction liquid nozzle is arranged above the input end of the algae mud uniform distributor, and a discharge hole is formed in the bottom of the algae mud uniform distributor. According to the utility model, the purposes of linked coordinated operation of microalgae harvesting and extraction and automatic acquisition of microalgaemetabolites can be achieved.

Microalgae harvesting device with adjustable inclined plane

Inventor(s): WU HUAIZHI; LYU XUEFENG; DUAN YANGKAI; ZHANG KAI; LIU XIANG; LI XIN +

Applicant(s): QINGDAO INST BIOENERGY & BIOPROCESS TECH CAS +

The utility model relates to the technical field of microalgae harvesting. The utility model relates to a microalgae harvesting device, in particular to a microalgae harvesting device with an adjustable slope. The device comprises an algae liquid output pipe, a filter membrane, a filter screen pore plate, a harvesting support frame, a slope adjusting mechanism, an algae mud collecting tank and analgae liquid collecting tank, wherein the plurality of filter screen pore plates are arranged on the harvesting support frame in a stepped manner; a filter membrane is arranged on each filter screen pore plate; an algae liquid output pipe is arranged on the upper side of the input end of the highest filter screen pore plate; an algae mud collecting tank is arranged on the outer side of the outputend of the lowest filter screen pore plate, an algae liquid collecting pool is arranged on the lower side of the harvesting supporting frame, the input end of the filter screen pore plate is hinged tothe harvesting supporting frame, and a slope adjusting mechanism is arranged between the filter screen pore plate and the harvesting supporting frame. The inclination of the filter screen pore platecan be adjusted according to the moisture content and the filtering dehydration condition of microalgae harvested algae mud, and the basic stability of the microalgae harvesting dehydration rate is ensured.

PROCESS FOR EXTRACTION OF NUTRACEUTICAL COMPOUNDS FROM MICROALGAE BY USING CO2 IN SUPERCRITICAL CONDITIONS

Inventor(s): CICCI AGNESE [IT]; IAQUANIELLO GAETANO [IT]; MAZZELLI ALESSIO [IT] +

Applicant(s): BIO P S R L [IT] +

A process that allows the extraction of compounds of nutraceutical interest (specifically omega-3 and carotenoids) from microalgae and their separation through the use of CO2 in supercritical conditions (and when necessary a co-solvent), at the same time, wherein the removal of an unwanted component (tripalmitin) from the lipid extract, always by using supercritical CO2 in a fractional extraction, is advantageously carried out using its different extraction kinetics respect to the component present in the lipid phase.

Pig farm fermentation tail liquid continuous treatment system coupled with microalgae efficient culture and operation process thereof

Inventor(s): SUN YAHUI; SHAO HAN; JIANG XIAOXIANG; DAI CHUANCHAO; XIE TAOJIN; WU YUQING; HU JUN; WANG YUNJUN; DUAN ZIYANG +

Applicant(s): UNIV NANJING +

The invention provides a pig farm fermentation tail liquid continuous treatment system coupled with microalgae efficient culture. The pig farm fermentation tail liquid continuous treatment system mainly comprises a pig farm fermentation tail liquid nutritive salt recovery module, a CO2 pre-dissolution module and a microalgae biological membrane culture module, wherein the pig farm fermentation tail liquid nutrient salt recovery module comprises a chamber and microporous filter tube bundles distributed in the chamber; the CO2 pre-dissolution module comprises an aerator; the microalgae biological membrane culture module comprises a transparent solid light guide material with a bulge structure on the surface; all the modules communicate with one another through pipelines, and substance circulation among all the modules is achieved under driving of a pump. Pig farm fermentation tail liquid is subjected to component screening through the microporous filter tube bundles, the yield of microalgae biomass is increased by introducing the transparent solid light guide material with a bulge structure on the surface, a pig farm fermentation tail liquid treatment and microalgae efficient culturecoupled system is established, continuous and cyclic utilization of substances is realized, and the treatment cost is reduced.

Preparation process for preparing sodium copper chlorophyllin from microalgae and product thereof

Inventor(s): ZHANG JUNBING; XIONG YONG; DING XIAOQIANG; LUO ZHONGGUO; FANG JUNJUN; CHEN JUNFENG; QIU YUN; CAO YUQING +

Applicant(s): JIANGXI DANXIA BIOTECHNOLOGY CO LTD

The invention provides a preparation process for preparing sodium copper chlorophyllin from microalgae and a product thereof. The preparation process comprises the following steps: selecting raw materials from microalgae, conducting extracting, carrying out primary acidification copper substitution, filtering, separating, concentrating, saponifying, secondary acidification copper substitution andprimary impurity removal, conducting saponifying to form a salt, conducting drying, secondary impurity removal and sterilizing, conducting sieving to remove iron, and conducting mixing, packaging andthe like, thereby obtaining a sodium copper chlorophyllin finished product. According to the method, the raw materials contain rich chlorophyll, the chlorophyll grows rapidly, is easy to culture and is not limited by field seasons, the production scale is adjustable, and the extracted chlorophyll immediately undergoes a conversion reaction with Cu<2+>, so that the extracted chlorophyll is prevented from being damaged by light and heat to influence the subsequent yield; and the obtained extract is higher in stability, has higher heat resistance and light resistance, and is beneficial to improving the yield and the product quality.

TWO-STAGE PROCESS FOR PRODUCING OIL FROM MICROALGAE

Inventor(s): OYLER JAMES R [US] +

Applicant(s): GENIFUEL CORP [US] +

First page clipping of US2021071213 (A1)

A process for production of biofuels from algae can include cultivating an oil-producing algae by promoting sequential photoautotrophic and heterotrophic growth. The method can further include producing oil by heterotrophic growth of algae wherein the heterotrophic algae growth is achieved by introducing a sugar feed to the oil-producing algae. An algal oil can be extracted from the oil-producing algae, and can be converted to form biodiesel.

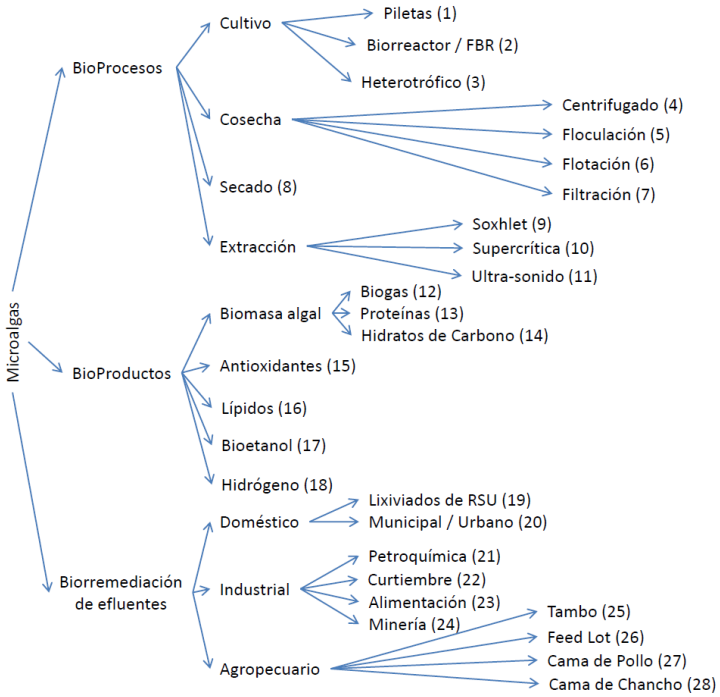
EVENTOS

Algae Biomass Summit from September
28th to October 27th 2021.
https://www.algaebiomasssummit.org/page/Registration

CURSO Online y Gratuito
"BIORREFINERIAS a partir de MICROALGAS y PLANTAS"
28 de Junio al 1 de Julio, 2021
http://www.solabiaa.org/web2/2020/12/15/anuncio-curso-online-biorrefinerias-a-partir-de-microalgas-y-plantas/

Árbol de categorías

Español



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