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Contenido

A Carbon Fixation Enhanced Chlamydomonas reinhardtii Strain for Achieving the Double-Win Between Growth and Biofuel Production Under Non-stressed Conditions

Autor: Zhen Zhu
Front Bioeng Biotechnol. 2021 Jan 12;8:603513.

ABSTRACT
The stressed cultivations are widely used in microalgae R&D for the biofuel production with the repress on growth to a certain degree, which limits the overall productivity. The balance between the growth and energy storage compounds accumulation is a target needing the combination of both strain selection or construction and culture optimization. Here, an engineered strain of Chlamydomonas reinhardtii, in which the chloroplast type glyceraldehyde-3-phosphate dehydrogenase (cGAPDH) was overexpressed and named as P3-GAPDH, was cultured on the Algal Station platform.
Compared with wild type (WT), C. reinhardtii CC137c, in Tris-acetate-phosphate (TAP) medium, the highest density of WT and P3-GAPDH were 1.23 ± 0.13 and 1.74 ± 0.09 g L -1 within 96 h, and the maximum biomass productivity was 24.30 ± 1.65 and 28.54 ± 1.43 mg L -1 h -1 , respectively. In terms of the energy storage compounds, both carbohydrate and fatty acids content doubled in P3-GAPDH, from 0.13 ± 0.02 to 0.26 ± 0.04 g L -1 for carbohydrate and from 0.08 ± 0.01 to 0.16 ± 0.01 g L - 1 for fatty acids, among which poly unsaturated fatty acids increased by 65.8%. Together with the continuous monitor of the chlorophyll fluorescence dynamics parameters F v /F m and F v '/F m ' and pH of culture, enhanced Calvin cycle by overexpressed cGAPDH promoted the carbon conversion and subsequent energy storage compounds accumulation. C. reinhardtii P3-GAPDH strain showed the potential as a good chassis with high carbon conversion ability.

Algae-Bacteria Consortia as a Strategy to Enhance H(2) Production

Autor: Neda Fakhimi
Cells. 2020 May 29;9(6):1353

ABSTRACT
Biological hydrogen production by microalgae is a potential sustainable, renewable and clean source of energy. However, many barriers limiting photohydrogen production in these microorganisms remain unsolved. In order to explore this potential and make biohydrogen industrially affordable, the unicellular microalga Chlamydomonas reinhardtii is used as a model system to solve barriers and identify new approaches that can improve hydrogen production. Recently, Chlamydomonas-bacteria consortia have opened a new window to improve biohydrogen production. In this study, we review the different consortia that have been successfully employed and analyze the factors that could be behind the improved H 2 production.

Anemonia sulcata and Its Symbiont Symbiodinium as a Source of Anti-Tumor and Anti-Oxoxidant .Compounds for Colon Cancer Therapy: A Preliminary in Vitro Study

Autor: Laura Cabeza
Biology (Basel). 2021 Feb 8;10(2):134.

ABSTRACT
Recently, invertebrate marine species have been investigated for the presence of natural products with antitumor activity.
We analyzed the invertebrate Anemonia sulcata with (W) and without (W/O) the presence of its microalgal symbiont Symbiodinium as a source of bioactive compounds that may be applied in the therapy and/or prevention of colorectal cancer (CRC). Animals were mechanically

homogenized and subjected to ethanolic extraction. The proximate composition and fatty acid profile were determined. In addition, an in vitro digestion was performed to study the potentially dialyzable fraction. The antioxidant and antitumor activity of the samples and the digestion products were analyzed in CRC cells in vitro. Our results show a high concentration of polyunsaturated fatty acid in the anemone and a great antioxidant capacity, which demonstrated the ability to prevent cell death and a high antitumor activity of the crude homogenates against CRC cells and multicellular tumor spheroids, especially W/O symbiont. These preliminary results support that Anemonia sulcate could be a source of bioactive compounds with antioxidant and antitumor potential against CRC and that the absence of its symbiont may enhance these properties. Further studies will be necessary to define the bioactive compounds of Anemonia sulcata and their mechanisms of action.

Apparent Digestibility of Macronutrients and Fatty Acids from Microalgae (Schizochytrium sp.) Fed to Rainbow Trout (Oncorhynchus mykiss): A Potential Candidate for Fish Oil Substitution

Autor: Amélie Bélanger
Animals (Basel). 2021 Feb 9;11(2):456.

ABSTRACT
Aquaculture feed formulation has recently turned its focus to reduce the reliance on marine-derived resources and utilize alternative feedstuffs, as an approach to improve the environmental sustainability of the aquaculture sector. The fish oil market is highly volatile, and availability of this commodity is continuously decreasing for use in aquaculture. Currently, a growing number of commercial efforts producing microalgae are providing omega 3-rich oil for sustainable aquaculture feed. This study was focused to determine the nutrient digestibility of a marine microalga, Schizochytrium spp., which is rich in docosahexaenoic acid (DHA) and long-chain polyunsaturated fatty acids (LC-PUFA), as a novel dietary lipid source that could be utilized effectively by rainbow trout (Oncorhynchus mykiss). A whole-cell Schizochytrium spp. biomass was used in the digestibility experiment at two different temperatures, 8 °C and 15 °C. No significant differences were detected between the two temperatures for the apparent digestibility coefficients (ADCs) of the dry matter (94.3 ± 4.9%), total lipids (85.8 ± 0.0%), crude proteins (89.5 ± 1.8%), energy (83.1 ± 1.7%) and fatty acids (85.8 ± 7.5%). The ADCs of the nutrients, energy, DHA and other fatty acids showed that Schizochytrium spp. is a high-quality candidate for fish oil substitution and supplement of LC-PUFA in fish feed with vegetable oils.

Assessment of biomass potentials of microalgal communities in open pond raceways using mass Cultivation.

Autor: Seung-Woo Jo
PeerJ. 2020 Jul 16;8:e9418

ABSTRACT
Metagenome studies have provided us with insights into the complex interactions of microorganisms with their environments and hosts. Few studies have focused on microalgae-associated metagenomes, and no study has addressed aquatic microalgae and their bacterial communities in open pond raceways (OPRs). This study explored the possibility of using microalgal biomasses from OPRs for biodiesel and biofertilizer production. The fatty acid profiles of the biomasses and the physical and chemical properties of derived fuels were evaluated. In addition, the phenotype-based environmental adaptation ability of soybean plants was assessed. The growth rate, biomass, and lipid productivity of microalgae were also examined during mass cultivation from April to November 2017. Metagenomics analysis using MiSeq identified ~127 eukaryotic phylotypes following mass cultivation with (OPR 1) or without (OPR 3) a semitransparent film. Of these, ~80 phylotypes were found in both OPRs, while 23 and 24 phylotypes were identified in OPRs 1 and 3, respectively. The phylotypes belonged to various genera, such as Desmodesmus, Pseudopediastrum, Tetradesmus, and Chlorella, of which, the dominant microalgal species was Desmodesmus sp. On average, OPRs 1 and 3 produced ~8.6 and 9.9 g m -2 d -1 (0.307 and 0.309 DW L -1) of total biomass, respectively, of which 14.0 and 13.3 wt% respectively, was lipid content. Fatty acid profiling revealed that total saturated fatty acids (mainly C16:0) of biodiesel obtained from the microalgal biomasses in OPRs 1 and 3 were 34.93% and 32.85%, respectively; total monounsaturated fatty acids (C16:1 and C18:1) were 32.40% and 31.64%, respectively; and polyunsaturated fatty acids (including C18:3) were 32.68% and 35.50%, respectively. Fuel properties determined by empirical equations were within the limits of biodiesel standards ASTM D6751 and EN 14214. Culture solutions with or without microalgal biomasses enhanced the environmental adaptation ability of soybean plants,

increasing their seed production. Therefore, microalgal biomass produced through mass cultivation is excellent feedstock for producing high-quality biodiesel and biofertilizer.

Biobased Solvents for Pressurized Liquid Extraction of Nannochloropsis gaditana Omega-3 Lipids

Autor: Cristina Blanco-Llamero

Mar Drugs. 2021 Feb 12;19(2):107.

ABSTRACT
To develop greener extraction alternatives for microalgae biomass, ultrasound assisted extraction (UAE) and pressurized liquid extraction (PLE) with different biobased solvents were investigated, demonstrating that both techniques are useful alternatives for algal lipid extraction. Specifically, Nannochloropsis gaditana lipids were extracted by UAE and PLE at different temperatures and extraction times with sustainable solvents like 2-Methyltetrahydrofuran (2-MeTHF) and its mixtures with ethanol and other alcohols. The best oil yields for both PLE and UAE of N. gaditana were achieved with the mixture of 2-MeTHF:ethanol (1:3), reaching yields of up to 16.3%, for UAE at 50 °C and up to 46.1% for PLE at 120 °C. Lipidcomposition of the extracts was analyzed by HPLC-ELSD and by GC-MS to determine lipid species and fatty acid profile, respectively. Different fractionation of lipid species was achieved with PLE and solvent mixtures of different polarity. Thus, for the extraction of glycolipids, ethanolic extracts contained higher amounts of glycolipids and EPA, probably due to the higher polarity of the solvent. The optimized method was applied to microalgae Isochrysis galbana and Tetraselmis chuii showing the potential of mixtures of biobased solvents like 2-methyl-THF and ethanol in different proportions to efficiently extract and fractionate lipids from microalgal biomass.

Biomass, lipid accumulation kinetics, and the transcriptome of heterotrophic oleaginous microalga Tetradesmus bernardii under different carbon and nitrogen sources.

Autor: Baoyan Gao
Biotechnol Biofuels. 2021 Jan 6;14(1):4. doi: 10.1186/s13068-020-01868-9.

ABSTRACT
BACKGROUND: Heterotrophic cultivation of microalgae has been proposed as a viable alternative method for novel high- value biomolecules, enriched biomass, and biofuel production because of their allowance of high cell density levels, as well as simple production technology. Tetradesmus bernardii, a newly isolated high-yielding oleaginous microalga under photoautotrophic conditions, is able to grow heterotrophically, meaning that it can consume organic carbon sources in dark condition. We investigated the effect of different carbon/nitrogen (C/N) ratios on the growth and lipid accumulation of T. bernardii in heterotrophic batch culture under two nitrogen sources (NaNO 3 and CO(NH 2) 2). In addition, we conducted time-resolved transcriptome analysis to reveal the metabolic mechanism of T. bernardii in heterotrophic culture.
RESULTS: T. bernardii can accumulate high biomass concentrations in heterotrophic batch culture where the highest biomass of 46.09 g/L was achieved at 100 g/L glucose concentration. The rate of glucose to biomass exceeded 55% when the glucose concentration was less than 80 g/L, and the C/N ratio was 44 at urea treatment. The culture was beneficial to lipid accumulation at a C/N ratio between 110 and 130. NaNO 3 used as a nitrogen source enhanced the lipid content more than urea, and the highest lipid content was 45% of dry weight. We performed RNA-seq to analyze the time-resolved transcriptome of T. bernardii. As the nitrogen was consumed in the medium, nitrogen metabolism-related genes were significantly up-regulated to speed up the N metabolic cycle. As chloroplasts were destroyed in the dark, the metabolism of cells was transferred from chloroplasts to cytoplasm. However, storage of carbohydrate in chloroplast remained active, mainly the synthesis of starch, and the precursor of starch synthesis in heterotrophic culture may largely come from the absorption of organic carbon source (glucose). With regard to lipid metabolism, the related genes of fatty acid synthesis in low nitrogen concentration increased gradually with the extension of cultivation time.
CONCLUSION: T. bernardii exhibited rapid growth and high lipid accumulation in heterotrophic culture. It may be a potential candidate for biomass and biofuel production. Transcriptome analysis showed that multilevel regulation ensured the conversion from carbon to the synthesis of carbohydrate and lipid.

Bioprospecting White-Rot Basidiomycete Irpex lacteus for Improved Extraction of Lignocellulose-Degrading Enzymes and Their Further Application

Autor: Linda Mezule
J Fungi (Basel). 2020 Oct 29;6(4):256. doi: 10.3390/jof6040256.

ABSTRACT
Lignocellulosic biomass can be used as a source for energy, fuel and valuable chemical production. From all available technologies, biological approaches have been recognized as the most environmentally friendly and sustainable ones. At the same time, high conversion costs, low efficiency and environmental issues still hinder the introduction of biological processes into industrial scale manufacturing. The aim of this study was to determine the most suitable enzyme cocktail recovery conditions from a biomass-fungal culture of the white-rot basidiomycete Irpex lacteus. Subsequent evaluation of the overall enzyme cocktail efficiency to release fermentable carbohydrates from biomass showed that prolonged fungal cultivation decreases the quality of the produced enzyme cocktail. At the same time, introduction of ultrasound pre- treatment during enzyme extraction improved the recovered enzyme cocktail efficiency in converting biomass to fermentable sugars, yielding up to 0.25 g of fermentable sugar per g dry hay biomass and up to 0.11 g per g dried straw or microalgae substrates. The results demonstrated that the production of lignocellulose-degrading enzymes from fungi is more sensitive than previously described, especially in terms of fungal growth, culture sterility and incubation conditions.

Chlamydomonas reinhardtii LHCSR1 and LHCSR3 proteins involved in photoprotective non-photochemical quenching have different quenching efficiency and different carotenoid affinity

Autor: Federico Perozeni
Sci Rep. 2020 Dec 15;10(1):21957.

ABSTRACT
Microalgae are unicellular photosynthetic organisms considered as potential alternative sources for biomass, biofuels or high value products. However, their limited biomass productivity represents a bottleneck that needs to be overcome to meet the applicative potential of these organisms. One of the domestication targets for improving their productivity is the proper balance between photoprotection and light conversion for carbon fixation. In the model organism for green algae, Chlamydomonas reinhardtii, a photoprotective mechanism inducing thermal dissipation of absorbed light energy, called Non-photochemical quenching (NPQ), is activated even at relatively low irradiances, resulting in reduced photosynthetic efficiency. Two pigment binding proteins, LHCSR1 and LHCSR3, were previously reported as the main actors during NPQ induction in C. reinhardtii. While previous work characterized in detail the functional properties of LHCSR3, few information is available for the LHCSR1 subunit. Here, we investigated in vitro the functional properties of LHCSR1 and LHCSR3 subunits: despite high sequence identity, the latter resulted as a stronger quencher compared to the former, explaining its predominant role observed in vivo. Pigment analysis, deconvolution of absorption spectra and structural models of LHCSR1 and LHCR3 suggest that different quenching efficiency is related to a different occupancy of L2 carotenoid binding site.

Chromochloris zofingiensis (Chlorophyceae) Divides by Consecutive Multiple Fission Cell-Cycle under Batch and Continuous Cultivation.

Autor: Idan Koren
Biology (Basel). 2021 Feb 16;10(2):157. doi: 10.3390/biology10020157.

ABSTRACT
Several green algae can divide by multiple fission and spontaneously synchronize their cell cycle with the available light regime. The yields that can be obtained from a microalgal culture are directly affected by cell cycle events. Chromochloris zofingiensis is considered as one of the most promising microalgae for biotechnological applications due to its fast growth and the flexible trophic capabilities. It is intensively investigated in the context of bio-commodities production (carotenoids, storage lipids); however, the pattern of cell-cycle events under common cultivation strategies was not yet characterized for C. zofingiensis. In this study, we have employed fluorescence microscopy to characterize the basic cell- cycle dynamics under

batch and continuous modes of phototrophic C. zofingiensis cultivation. Staining with SYBR green- applied in DMSO solution-enabled, for the first time, the clear and simple visualization of polynuclear stages in this microalga. Accordingly, we concluded that C. zofingiensis divides by a consecutive pattern of multiple fission, whereby it spontaneously synchronizes growth and cell division according to the available illumination regime. In high-light continuous culture or low-light batch culture, C. zofingiensis cell-cycle was completed within several light-dark (L/D) cycles (14 h/10 h); however, cell divisions were synchronized with the dark periods only in the high-light continuous culture. In both modes of cultivation, daughter cell release was mainly facilitated by division of 8 and 16-polynuclear cells. The results of this study are of both fundamental and applied science significance and are also important for the development of an efficient nuclear transformation system for C. zofingiensis.

Co-Hydrothermal gasification of Chlorella vulgaris and hydrochar: The effects of waste-to-solid biofuel production and blending concentration on biogas generation

Autor: Greta Sztancs
Bioresour Technol. 2020 Apr;302:122793.

ABSTRACT
This study investigates enhanced biogas production via co-Hydrothermal gasification (co-HTG) of wet Chlorella vulgaris biomass and hydrochar (HC). Hydrothermal carbonization was applied to valorize struvite containing waste microalgae stream into solid bio-fuel with improved combustion properties. The effects of HC quality and mixing ratio are investigated on biogas yield, composition and carbon conversion ratio. The results show that the application of blending components promotes H 2 , CH 4 formation and selectivity in hydrothermal gasification. The total co-HTG gas yield is increased from 19.13 to 46.95 mol kg -1 at 650 °C and 300 bar by applying 5 wt% HC blending concentration and reduced level of volatile matter content (24.61 wt%). The obtained high hydrogen, methane yields and carbon conversion ratio (19.49, 2.98 mol kg -1 , 82.31%, respectively) indicate effective hydrothermal upgrading potentials in case of wet and waste biomass feedstocks.

Comprehensive Utilization of Marine Microalgae for Enhanced Co-Production of Multiple Compounds

Autor: Ruijuan Ma
Mar Drugs. 2020 Sep 16;18(9):467. doi: 10.3390/md18090467.

ABSTRACT
Marine microalgae are regarded as potential feedstock because of their multiple valuable compounds, including lipids, pigments, carbohydrates, and proteins. Some of these compounds exhibit attractive bioactivities, such as carotenoids, ω-3 polyunsaturated fatty acids, polysaccharides, and peptides. However, the production cost of bioactive compounds is quite high, due to the low contents in marine microalgae. Comprehensive utilization of marine microalgae for multiple compounds production instead of the sole product can be an efficient way to increase the economic feasibility of bioactive compounds production and improve the production efficiency. This paper discusses the metabolic network of marine microalgal compounds, and indicates their interaction in biosynthesis pathways. Furthermore, potential applications of co-production of multiple compounds under various cultivation conditions by shifting metabolic flux are discussed, and cultivation strategies based on environmental and/or nutrient conditions are proposed to improve the co-production. Moreover, biorefinery techniques for the integral use of microalgal biomass are summarized. These techniques include the co-extraction of multiple bioactive compounds from marine microalgae by conventional methods, super/subcritical fluids, and ionic liquids, as well as direct utilization and biochemical or thermochemical conversion of microalgal residues. Overall, this review sheds light on the potential of the comprehensive utilization of marine microalgae for improving bioeconomy in practical industrial application.

Controlling of two destructive zooplanktonic predators in Chlorella mass culture with surfactants

Autor: Xiaobin Wen
Biotechnol Biofuels. 2021 Jan 14;14(1):21.

ABSTRACT

BACKGROUND: Predatory flagellates and ciliates are two common bio-contaminants which frequently cause biomass losses in Chlorella mass culture. Efficient and targeted ways are required to control these contaminations in Chlorella mass cultivation aiming for biofuel production especially.
RESULTS: Five surfactants were tested for its ability to control bio-contaminations in Chlorella culture. All five surfactants were able to eliminate the contaminants at a proper concentration. Particularly the minimal effective concentrations of sodium dodecyl benzene sulfonate (SDBS) to completely eliminate Poterioochromonas sp. and Hemiurosomoida sp. were 8 and 10 mg L -1 , respectively, yet the photosynthesis and viability of Chlorella was not significantly affected. These results were further validated in Chlorella mass cultures in 5, 20, and 200 m 2 raceway ponds.
CONCLUSIONS: A chemical method using 10 mg L -1 SDBS as pesticide to control predatory flagellate or ciliate contamination in Chlorella mass culture was proposed. The method helps for a sustained microalgae biomass production and utilization, especially for biofuel production.

Cultivation of the Acidophilic Microalgae Galdieria phlegrea with Wastewater: Process Yields

Autor: Maria Rosa di Cicco
Int J Environ Res Public Health. 2021 Feb 26;18(5):2291.

ABSTRACT
Algal based wastewater treatment offers the opportunity to recover, in the form of biomass, the nutrients and internal chemical energy of wastewater. Recently, there has been a growing interest in the use of extremophilic microalgae, as they can easily adapt to difficult and often pollutant-rich environments. The thermo-acidophilic microalga Galdieria phlegrea is a species of recent discovery and great metabolic versatility, but it has still been poorly studied. Here, G. phlegrea was cultivated using raw municipal wastewater in 1 L Erlenmeyer flasks with 700 mL working volume at 37 °C for up to nine days. During the cultivation phase, biomass growth, phycocyanin content, ammonium and phosphate removal from the wastewater, lipid fraction, total carbon and nitrogen in the biomass, and variation in δ 13 C and δ 15 N isotopic ratios (a novel analytical contribution in these experiments) were monitored. Results indicated that G. phlegrea was able to grow in raweffluent, where it removed more than 50% ammonium and 20% phosphate in 24 h; total lipid content was in the range of 11-22%, while average C-N content was of 45% and 6%, respectively; isotopic analyses proved to be a useful support in identifying C and N metabolic pathways from effluent to biomass. Overall, G. phlegrea showed consistent performance with similar Cyanidiophyceae and is a potentially viable candidate for municipal wastewater valorization from a circular economy perspective.

Data on growth, productivity, pigments and proximate composition of indigenous marine microalgae isolated from Cox's Bazar Coast

Autor: Zahidul Islam
Data Brief. 2021 Feb 11;35:106860. doi: 10.1016/j.dib.2021.106860. eCollection 2021 Apr.

ABSTRACT
Data on growth, productivity, pigments and proximate composition of the four different indigenous marine microalgae (isolated from Cox's Bazar Coast) were collected to compare the growth performance, pigments and nutritional composition. Chlorella sp., Nannochloropsis sp., Tetraselmis sp. and Chaetoceros sp. are the four different marine microalgae. Growth curve was determined as the prerequisite to identify the stationary phase for each of the isolated microalgae. Data on growth curves were collected in terms of cell density and optical density to observe the growth rates and division per day. Isolated species were mass cultured in commercial culture medium. When the culture reached at stationary phase, microalgae were extracted to determine productivity, pigments, and proximate composition. The data of productivity (volumetric, areal and lipid productivity), pigments (Chlorophyll a, b, c, carotenoids, and phycobiliproteins), and proximate composition (protein, lipid, and carbohydrate) were significantly ($p < 0.05$) different among the four different microalgae. Therefore, this data will contribute to the selection of potential microalgae species through proper characterization for vast industrializations.

Denitrification, Nitrogen Uptake, and Organic Matter Quality Undergo Different Seasonality in Sandy and Muddy Sediments of a Turbid Estuary

Autor: Marco Bartoli
Front Microbiol. 2021 Jan 21;11:612700. doi: 10.3389/fmicb.2020.612700. eCollection 2020.

ABSTRACT
The interaction between microbial communities and benthic algae as nitrogen (N) regulators in poorly illuminated sediments is scarcely investigated in the literature. The role of sediments as sources or sinks of N was analyzed in spring and summer in sandy and muddy sediments in a turbid freshwater estuary, the Curonian Lagoon, Lithuania. Seasonality in this ecosystem is strongly marked by phytoplankton community succession with diatoms dominating in spring and cyanobacteria dominating in summer. Fluxes of dissolved gas and inorganic N and rates of denitrification of water column nitrate (D w) and of nitrate produced by nitrification (D n) and sedimentary features, including the macromolecular quality of organic matter (OM), were measured. Shallow/sandy sites had benthic diatoms, while at deep/muddy sites, settled pelagic microalgae were found. The OM in surface sediments was always higher at muddy than at sandy sites, and biochemical analyses revealed that at muddy sites the OM nutritional value changed seasonally. In spring, sandy sediments were net autotrophic and retained N, while muddy sediments were net heterotrophic and displayed higher rates of denitrification, mostly sustained by D w . In summer, benthic oxygen demand increased dramatically, whereas denitrification, mostly sustained by D n , decreased in muddy and remained unchanged in sandy sediments. The ratio between denitrification and oxygen demand was significantly lower in sandy compared with muddy sediments and in summer compared with spring.
Muddy sediments displayed seasonally distinct biochemical composition with a larger fraction of lipids coinciding with cyanobacteria blooms and a seasonal switch from inorganic N sink to source. Sandy sediments had similar composition in both seasons and retained inorganic N also in summer. Nitrogen uptake by microphytobenthos at sandy sites always exceeded the amount loss via denitrification, and benthic diatoms appeared to inhibit denitrification, even in the dark and under conditions of elevated N availability. In spring, denitrification attenuated N delivery from the estuary to the coastal area by nearly 35%. In summer, denitrification was comparable (~100%) with the much lower N export from the watershed, but N loss was probably offset by large rates of N-fixation.

Edible Microalgae and Their Bioactive Compounds in the Prevention and Treatment of Metabolic Alterations

Autor: Sara Ramos-Romero
Nutrients. 2021 Feb 9;13(2):563.

ABSTRACT
Marine and freshwater algae and their products are in growing demand worldwide because of their nutritional and functional properties. Microalgae (unicellular algae) will constitute one of the major foods of the future for nutritional and environmental reasons. They are sources of high-quality protein and bioactive molecules with potential application in the modern epidemics of obesity and diabetes. They may also contribute decisively to sustainability through carbon dioxide fixation and minimization of agricultural land use. This paper reviews current knowledge of the effects of consuming edible microalgae on the metabolic alterations known as metabolic syndrome (MS). These microalgae include Chlorella, Spirulina (Arthrospira) and Tetraselmis as well as Isochrysis and Nannochloropsis as candidates for human consumption. Chlorella biomass has shown antioxidant, antidiabetic, immunomodulatory, antihypertensive, and antihyperlipidemic effects in humans and other mammals. The components of microalgae reviewed suggest that they may be effective against MS at two levels: in the early stages, to work against the development of insulin resistance (IR), and later, when pancreatic –cell function is already compromised. The active components at both stages are antioxidant scavengers and anti-inflammatory lipid mediators such as carotenoids and -3 PUFAs (eicosapentaenoic acid/docosahexaenoic acid; EPA/DHA), prebiotic polysaccharides, phenolics, antihypertensive peptides, several pigments such as phycobilins and phycocyanin, and some vitamins, such as folate. As a source of high-quality protein, including an array of bioactive molecules with potential activity against the modern epidemics of obesity and diabetes, microalgae are proposed as excellent foods for the future.
Moreover, their incorporation into the human diet would decisively contribute to a more sustainable world because of their roles in carbon dioxide fixation and reducing the use of land for agricultural purposes.

Effect of post-treatment process of microalgal hydrolysate on bioethanol production

Autor: Gyeongho Seon
Sci Rep. 2020 Oct 7;10(1):16698.

ABSTRACT
Microalgae accumulate abundant lipids and are a promising source for biodiesel. However, carbohydrates account for 40% of microalgal biomass, an important consideration when using them for the economically feasible production of biodiesel.
In this study, different acid hydrolysis and post-treatment processing of Chlorella sp. ABC-001 was performed, and the effect of these different hydrolysates on bioethanol yield by Saccharomyces cerevisiae KL17 was evaluated. For hydrolysis using H 2 SO 4 , the neutralization using Ca(OH) 2 led to a higher yield (0.43 g ethanol/g sugars) than NaOH (0.27 g ethanol/g sugars). Application of electrodialysis to the H 2 SO 4 + NaOH hydrolysate increased the yield to 0.35 g ethanol/g sugars, and K + supplementation further enhanced the yield to 0.41 g ethanol/g sugars. Hydrolysis using HNO 3 led to the generation of reactive species. Neutralization using only NaOH yielded 0.02 g ethanol/g sugars, and electrodialysis provided only a slight enhancement (0.06 g ethanol/g sugars). However, lowering the levels of reactive species further increased the yield to 0.25 g ethanol/g sugars, and K + supplementation increased the yield to 0.35 g ethanol/g sugars. Overall, hydrolysis using H 2 SO 4 + Ca(OH) 2 provided the highest ethanol yield, and the yield was almost same as from conventional medium. This research emphasizes the importance of post-treatment processing that is modified for the species or strains used for bioethanol fermentation.

Effects of Nitrogen Supplementation Status on CO(2) Biofixation and Biofuel Production of the Promising Microalga Chlorella sp. ABC-001

Autor: Jun Muk Cho
J Microbiol Biotechnol. 2020 Aug 28;30(8):1235-1243.

ABSTRACT
The use of microalgal biomass as feedstock for biofuels has been discussed for decades as it provides a sustainable approach to producing fuels for the future. Nonetheless, its feasibility has not been established yet and various aspects of biomass applications such as CO 2 biofixation should also be explored. Therefore, in this study, the CO 2 biofixation and lipid/carbohydrate production potential of Chlorella sp. ABC-001 were examined under various nitrogen concentrations.
The highest biomass productivity and CO 2 biofixation rate of 0.422 g/l/d and 0.683 g/l/d, respectively, were achieved under a nitrogen-rich condition (15 mM nitrate). Carbohydrate content was generally proportional to initial nitrate concentration and showed the highest value of 41.5% with 15 mM. However, lipid content showed an inverse relationship with nitrogen supplementation and showed the highest value of 47.4% with 2.5 mM. In consideration as feedstock for biofuels (bioethanol, biodiesel, and biogas), the sum of carbohydrate and lipid contents were examined and the highest value of 79.6% was achieved under low nitrogen condition (2.5 mM). For lipid-based biofuel production, low nitrogensupplementation should be pursued. However, considering the lower feasibility of biodiesel, pursuing CO 2 biofixation and the production of carbohydrate-based fuels under nitrogenrich condition might be more rational. Thus, nitrogen status as a cultivation strategy must be optimized according to the objective, and this was confirmed with the promising alga Chlorella sp. ABC-001.

Effects of Phlorotannins on Organisms: Focus on the Safety, Toxicity, and Availability of Phlorotannins

Autor: Bertoka Fajar Surya Perwira Negara
Foods. 2021 Feb 19;10(2):452. doi: 10.3390/foods10020452.

ABSTRACT
Phlorotannins are polyphenolic compounds produced via polymerization of phloroglucinol, and these compounds have varying molecular weights (up to 650 kDa). Brown seaweeds are rich in phlorotannins compounds possessing various biological activities, including algicidal, antioxidant, anti-inflammatory, antidiabetic, and anticancer activities. Many review papers on the chemical characterization and quantification of phlorotannins and their functionality have been published to date. However, although studies on the safety and toxicity of these phlorotannins have been conducted, there have been no articles reviewing this topic. In this review, the safety and toxicity of phlorotannins in different organisms are discussed.
Online databases (Science Direct, PubMed, MEDLINE, and Web of Science) were searched, yielding 106 results. Following removal of duplicates and application of the exclusion criteria, 34 articles were reviewed. Phlorotannins from brown seaweeds showed low toxicity in cell lines, invertebrates, microalgae, seaweeds, plants, animals (fish, mice, rats, and dogs), and humans. However, the safety and toxicity of phlorotannins in aquaculture fish, livestock, and companion animals are limited. Further studies in these organisms are necessary to carry out a systematic analysis of the safety and toxicity of phlorotannins and to further identify the potential of phlorotannins as functional foods, feeds, and pharmaceuticals.

Effects of substrate on growth and lipid accumulation of Tribonema sp. FACHB-1786

Autor: Ting Zhang
Sheng Wu Gong Cheng Xue Bao. 2020 Nov 25;36(11):2478-2493.

ABSTRACT
Filamentous microalga Tribonema sp. has the advantages of highly resistance to zooplankton-predation, easy harvesting, and high cellular lipid content, in particular large amounts of palmitoleic acid (PA) and eicosapentaenoic acid (EPA).
Therefore, Tribonema sp. is considered as a promising biomass feedstock to produce biodiesel and high-value products. In this work, we studied the effect of different concentrations of nitrogen ($NaNO_3$: 255-3 060 mg/L), phosphorus (K_2HPO_4: 4- 240 mg/L), iron ($(NH_4)_3FeC_{12}H_{10}O_{14}$: 0.6-12 mg/L) and magnesium ($MgSO_4$: 7.5-450 mg/L) on the biomass, lipid content, and fatty acid composition of Tribonema sp. FACHB-1786, aiming at enhancing cell lipid productivity. The growth of Tribonema sp. had a positive correlation with the concentration of magnesium, and the maximum biomass of Tribonema sp. (under the condition of 450 mg/L $MgSO_4$) was 8.09 g/L, much greater than those reported in previous studies using the same and other Tribonema species under autotrophic conditions. Different nitrogen concentrations exerted no significant effect on algal growth ($P > 0.05$), but a higher nitrogen concentration resulted in a greater amount of lipid in the cells. The maximum volumetric productivities of total lipids (319. 6 mg/(L·d)), palmitoleic acid (135.7 mg/(L·d)), and eicosapentaenoic acid (24.2 mg/(L·d)) of Tribonema sp. were obtained when the concentrations of $NaNO_3$, K_2HPO_4, $(NH_4)_3FeC_{12}H_{10}O_{14}$, and $MgSO_4$ were 765 mg/L, 80 mg/L, 6 mg/L, and 75 mg/L, respectively. This study will provide a reference for substrate optimization for Tribonema sp. growth and lipid production.

Effects of three antibiotics on growth and antioxidant response of Chlorella pyrenoidosa and Anabaena cylindrica

Autor: Xueqing Zhong
Ecotoxicol Environ Saf. 2021 Mar 15;211:111954. Epub 2021 Jan 19

ABSTRACT
Antibiotics are essential for treatments of bacterial infection and play important roles in the fields of aquaculture and animal husbandry. Antibiotics are accumulated in water and soil due to the excessive consumption and incomplete treatment of antibiotic wastewater. The accumulation of antibiotics in ecological systems leads to global environmentalrisks. The toxic effects of spiramycin (SPI), tigecycline (TGC), and amoxicillin (AMX) on Chlorella pyrenoidesa and Anabaena cylindrica were evaluated based on growth inhibition experiments, and determinations of ROS production and antioxidant enzyme activities (catalase, superoxide dismutase, and malondialdehyde). Half maximal effective concentrations (EC50) of TGC, SPI, and AMX for A. cylindrica were 62.52 μg/L, 38.40 μg/L, and 7.66 mg/L, respectively. Those were 6.20 mg/L, 4.58 mg/L, and > 2 g/L for C. pyrenoidesa, respectively. It was shown that A. cylindrica was much more sensitive to these antibiotics than C. pyrenoidesa. In addition, EC50 values of SPI and TGC were lower than that of AMX. It was indicated that SPI and TGC had higher toxic than AMX to C. pyrenoidesa and A. cylindrica. The current study is helpful to evaluating possible ecological risks of TGC, SPI, and AMX by green microalgae and cyanobacteria.

Energy conservation in photosynthetic microorganisms

Autor: Katsuhiko Okada
J Gen Appl Microbiol. 2020 Jun 17;66(2):59-65. Epub 2020 Apr 24.

ABSTRACT
Photosynthesis is a biological process of energy conversion from solar radiation to useful organic compounds for the photosynthetic organisms themselves. It, thereby, also plays a role of food production for almost all animals on the Earth.
The utilization of photosynthesis as an artificial carbon cycle is also attracting a lot of attention regarding its benefits for human life. Hydrogen and biofuels, obtained from photosynthetic microorganisms, such as microalgae and cyanobacteria, will be promising products as energy and material resources. Considering that the efficiency of bioenergy production is insufficient to replace fossil fuels at present, techniques for the industrial utilization of photosynthesis processes need to be developed intensively. Increase in the efficiency of photosynthesis, the yields of target substances, and the growth rates of algae and cyanobacteria must be subjects

for efficient industrialization. Here, we overview the whole aspect of the energy production from photosynthesis to biomass production of various photosynthetic microorganisms.

Enhanced Arthrospira platensis Biomass Production Combined with Anaerobic Cattle Wastewater Bioremediation

Autor: Denise Salvador de Souza
Bioenergy Res. 2021 Feb 28:1-14.

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 CO 2 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 BOD 5 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 NH 4 + , NO 3 - , P t , SO 4 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 Microencapsulation of C-Phycocyanin from Arthrospira by Freeze-Drying with Different Wall Materials

Autor: Wanida Pan-Utai
Food Technol Biotechnol. 2020 Dec;58(4):423-432.

ABSTRACT
RESEARCH BACKGROUND: C-phycocyanin (C-PC), a water-soluble blue pigment, was extracted from microalgae Arthrospira sp. C-PC could be a good substitute for synthetic pigments with high antioxidant activity. However, C-PC is unstable due to sensitivity to temperature, light, pH and oxygen; therefore, applications of C-PC in food and other products are limited.
Microencapsulation of C-PC using freeze-drying is a solution to this problem and is considered a suitable method for drying the heat-sensitive pigment.
EXPERIMENTAL APPROACH: C-phycocyanin was extracted from Arthrospira platensis. C-PC microcapsules were modified by freeze-drying, with maltodextrin and gum Arabic used as microencapsulation wall materials at different fractions from 0 to 100%. The physical properties including moisture content and water activity, solubility, hygroscopicity, bulk density, colour appearance, particle morphology and size distribution of the produced powders were evaluated. Thermal stability and antioxidant activity of freeze-dried microencapsulated C-PC powders were also assessed.
RESULTS AND CONCLUSIONS: Freeze-dried microencapsulated C-PC powders with maltodextrin and gum Arabic as wall materials gave high encapsulation efficiency of around 99%. At higher gum Arabic mass fraction, moisture content decreased and water activity improved. Maltodextrin gave higher solubility of C-PC powders whereas gum Arabic led to a similar colour of C-PC to those without microencapsulation. Freeze-dried microencapsulated C-PC powders were composed of different sized microparticles regardless of the combination of wall materials with amorphous glassy shapes. Thermal stability of encapsulated C-PC increased and also showed high antioxidant properties.
NOVELTY AND SCIENTIFIC CONTRIBUTION: This study demonstrates that the freeze-dried microencapsulated C-PC powders have pigment stability with antioxidant properties and are resistant to high temperatures. Therefore, they may have a potential for the development of microencapsulated C-PC as a functional ingredient with improved colour and bioactive properties. Such a product can be applied in food, cosmetic, biotechnology and nutraceutical industries.

Epoxidation of Fatty Acid Methyl Esters Derived from Algae Biomass to Develop Sustainable Bio- Based Epoxy Resins

Autor: Pamela Hidalgo
Polymers (Basel). 2020 Oct 10;12(10):E2313.

ABSTRACT
The objective of this research was to investigate the development of epoxides from Chlorella vulgaris lipids to obtain a novel bio-based resin. The process involved the production of fatty acid methyl esters (FAMEs) by in situ transesterification of microalgal biomass, followed by epoxidation of the FAMEs to obtain bioresin. During the FAME production process, an assessment was made of the main factors affecting the production of unsaturated fatty acid ethyl esters (UFAMEs), such as catalyst dosage and methanol:hexane volume ratio. For step epoxidation, an evaluation of the catalyst concentration, temperature and formic acid:hydrogen peroxide ratio was made. From the results obtained, UFAME production was maximized using 20 wt% of catalyst dosage and a volume ratio of 1:2 (v/v, methanol:hexane). Then, in the epoxidation stage, a higher yield was obtained using 1 wt% of catalyst with a volume ratio of 1:1 and maintaining a temperature of 70 °C. The bioresin was blended with neat epoxy resin (DGEBA) and cured with tetraethylenepentamine (TEPA). Bio-based resin was characterized via Fourier transform infrared spectroscopy (FTIR), Raman spectroscopy, thermogravimetric analysis (TGA) and dynamic mechanical analysis (DMA) to evaluate this material as an alternative source for oleochemistry.

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.

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.

Fixing the Broken Phosphorus Cycle: Wastewater Remediation by Microalgal Polyphosphates

Autor: Stephen P Slocombe
Front Plant Sci. 2020 Jun 30;11:982.

ABSTRACT
Phosphorus (P), in the form of phosphate derived from either inorganic (P i) or organic (P o) forms is an essential macronutrient for all life. P undergoes a biogeochemical cycle within the environment, but anthropogenic redistribution through inefficient agricultural practice and inadequate nutrient recovery at wastewater treatment works have resulted in a sustained transfer of P from rock deposits to land and aquatic environments. Our present and near future supply of P is primarily mined from rock P reserves in a limited number of geographical regions. To help ensure that this resource is adequate for humanity's food security, an energy-efficient means of recovering P from waste and recycling it for agriculture is required. This will also help to address excess discharge to water bodies and the resulting eutrophication.
Microalgae possess the advantage of polymeric inorganic polyphosphate (PolyP) storage which can potentially operate simultaneously with remediation of waste nitrogen and phosphorus streams and flue gases (CO 2 , SO x , and NO x). Having high productivity in photoautotrophic, mixotrophic or heterotrophic growth modes, they can be harnessed in wastewater remediation strategies for biofuel production either directly (biodiesel) or in conjunction with anaerobic

digestion (biogas) or dark fermentation (biohydrogen). Regulation of algal P uptake, storage, and mobilization is intertwined with the cellular status of other macronutrients (e.g., nitrogen and sulphur) in addition to the manufacture of other storage products (e.g., carbohydrate and lipids) or macromolecules (e.g., cell wall). A greater understanding of controlling factors in this complex interaction is required to facilitate and improve P control, recovery, and reuse from waste streams. The best understood algal genetic model is Chlamydomonas reinhardtii in terms of utility and shared resources. It also displays mixotrophic growth and advantageous sly, species of this genus are often found growing in wastewater treatment plants. In this review, we focus primarily on the molecular and genetic aspects of PolyP production or turnover and place this knowledge in the context of wastewater remediation and highlight developments and challenges in this field.

Flashing light emitting diodes (LEDs) induce proteins, polyunsaturated fatty acids and pigments in three microalgae

Autor: Serena Lima
J Biotechnol. 2021 Jan 10;325:15-24.

ABSTRACT
As the periodic emission of light pulses by light emitting diodes (LEDs) is known to stimulate growth or induce high value
biocompounds in microalgae, this flashing light regime was tested on growth and biochemical composition of the microalgae Nannochloropsis gaditana, Koliella antarctica and Tetraselmis chui. At low flashing light frequencies (e.g., 5 and 50 Hz, Duty cycle = 0.05), a strain-dependent growth inhibition and an accumulation of protein, polyunsaturated fatty acids, chlorophyll or carotenoids (lutein, β-carotene, violaxanthin and neoxanthin) was observed. In addition, a 4-day application of low-frequency flashing light to concentrated cultures increased productivities of eicosapentaenoic acid (EPA) and specific carotenoids up to three-fold compared to continuous or high frequency flashing light (500 Hz, Duty cycle = 0.05).
Therefore, applying low-frequency flashing light as finishing step in industrial production can increase protein, polyunsaturated fatty acids or pigment contents in biomass, leading to high-value algal products.

Identification and Biotechnical Potential of a Gcn5-Related N-Acetyltransferase Gene in Enhancing Microalgal Biomass and Starch Production

Autor: Zhongze Li
Front Plant Sci. 2020 Aug 28;11:544827.

ABSTRACT
Microalgae are promising feedstocks for starch production, which are precursors for bioenergy and chemicals manufacturing. Though starch biosynthesis has been intensively studied in the green alga Chlamydomonas reinhardtii, regulatory mechanisms governing starch metabolism in this model species have remained largely unknown to date. We proposed that altering triacylglycerol (TAG) biosynthesis may trigger intrinsic regulatory pathways governing starch metabolism. In accordance with the hypothesis, it was observed in this study that overexpression of the plastidial lysophosphatidic acid acyltransferase gene (i.e. LPAAT1) in C. reinhardtii significantly enhanced TAG biosynthesis undernitrogen (N)-replete conditions, whereas the starch biosynthesis was enhanced in turn under N depletion. By the exploitation of transcriptomics analysis, a putative regulatory gene coding Gcn5-related N-acetyltransferase (GNAT19) was identified, which was up-regulated by 11-12 times in the CrLPAAT1 OE lines. Overexpression of the cloned full-length CrGNAT19 cDNA led to significant increase in the starch content of C. reinhardtii cells grown under both N-replete and N- depleted conditions, which was up to 4 times and 26.7% higher than that of the empty vector control, respectively.
Moreover, the biomass yield of the CrGNAT19 OE lines reached 1.5 g L -1 after 2 days under N-depleted conditions, 72% higher than that of the empty vector control (0.87 g L -1). Overall, the yield of starch increased by 118.5% in CrGNAT19 OE lines compared to that of the control. This study revealed the great biotechnical potentials of an unprecedented GNAT19 gene in enhancing microalgal starch and biomass production.

Improving lipid productivity by engineering a control-knob gene in the oleaginous microalga Nannochloropsis oceanica

Autor: Xiao Han
Metab Eng Commun. 2020 Sep 3;11:e00142.

ABSTRACT
Nannochloropsis spp. are promising industrial microalgae for scalable oil production and the lipid production can be boosted by nutrient starvation and high irradiance. However, these stimuli halt growth, thereby decreasing overall productivity. In this study, we created transgenic N. oceanica where AtDXS gene encoding 1-deoxy-D-xylulose 5-phosphate
synthase (DXS) derived from Arabidopsis thaliana was overexpressed in vivo. Compared with the wild type (WT), engineered Nannochloropsis showed a higher CO 2 absorption capacity and produced more biomass, lipids, and carbohydrates with more robust growth in either preferred conditions or various stressed conditions (low light, high light, nitrogen starvation, and trace element depletion). Specifically, relative to the WT, lipid production increased by ~68.6% in nitrogen depletion (~1.08 g L -1) and ~110.6% in high light (~1.15 g L -1) in the transgenic strains. As for neutral lipid (triacylglycerol, TAG), the engineered strains produced ~93.2% more in nitrogen depletion (~0.77 g L -1) and ~148.6% more in high light (~0.80 g L -1) than the WT. These values exceed available records in engineered industrial microalgae. Therefore, engineering control- knob genes could modify multiple biological processes simultaneously and enable efficient carbon partitioning to lipid biosynthesis with elevated biomass productivity. It could be further exploited for simultaneous enhancement of growth property and oil productivity in more industrial microalgae.

In-situ lipid and fatty acid extraction methods to recover viable products from Nannochloropsis sp

Autor: Brian Brennan
Sci Total Environ. 2020 Dec 15;748:142464.

ABSTRACT
Nannochloropsis sp. has received increased attention by researchers in recent years due to its complexity and abundance of lipid structures. The lipids of this microalgae species have been identified to contain large quantities of neutral lipids which are capable of producing raw materials for nutraceuticals, food additives and biofuels. The production of biodiesel has received the greatest attention as there is an increase in global demand for both more fuel and more environmentally sustainable methods to produce such resources. The greatest challenges facing industries to mass produce viable products from microalgae involve the degradation of the cell wall and extracting the fatty acid of interest due to high costs. Various studies have shown that the extraction lipids from the microalgae can greatly influence the overall fatty acid composition.
Different extraction methods can result in recovering higher quantities of either saturated fatty acids, monounsaturated fatty acids or polyunsaturated fatty acids. Biodiesel production requires higher quantities of saturated fatty acids and monosaturated fatty acids as increased quantities of polyunsaturated fatty acids result in oxidation which decreases the performance of the biodiesel. Whereas, polyunsaturated fatty acids are required in order to produce pharmaceuticals and food additives such as omega 3. This review will focus on how different in-situ extraction methods for lipid and fatty acid recovery, influence the fatty acid composition of various Nannochloropsis species (oculate, gaditana, salina and oceanica).
The mechanical methods (microwave, ultrasonic and supercritical-carbon dioxide) of extraction for Nannochloropsis sp. Will be critically evaluated. The use of enzymes will also be addressed, for their ability to extract fatty acids in a more environmentally friendly manner. This paper will report on the viable by-products which can be produced using different extraction methods.

Incorporating a molecular antenna in diatom microalgae cells enhances photosynthesis

Autor: Gabriella Leone
Sci Rep. 2021 Mar 4;11(1):5209.

ABSTRACT
Diatom microalgae have great industrial potential as next-generation sources of biomaterials and biofuels. Effective scale- up of their production can be pursued by enhancing the efficiency of their photosynthetic process in a way that increases the solar-to-biomass conversion yield. A proof-of-concept demonstration is given of the possibility of enhancing the light absorption of algae and of increasing their efficiency in photosynthesis by in vivo incorporation of an organic dye which acts as an antenna and enhances cells' growth and biomass production without resorting to genetic modification. A molecular dye (Cy5) is incorporated in Thalassiosira weissflogii diatom cells by simply adding it to the culture medium and thus filling the orange gap that limits their absorption of sunlight. Cy5 enhances diatoms' photosynthetic oxygen

production and cell density by 49% and 40%, respectively. Cy5 incorporation also increases by 12% the algal lipid free fatty acid (FFA) production versus the pristine cell culture, thus representing a suitable way to enhance biofuel generation from algal species. Time-resolved spectroscopy reveals Förster Resonance Energy Transfer (FRET) from Cy5 to algal chlorophyll.
The present approach lays the basis for non-genetic tailoring of diatoms' spectral response to light harvesting, opening up new ways for their industrial valorization.

Investigation of carbon and energy metabolic mechanism of mixotrophy in Chromochloris zofingiensis

Autor: Zhao Zhang
Biotechnol Biofuels. 2021 Feb 4;14(1):36.

ABSTRACT
BACKGROUND: Mixotrophy can confer a higher growth rate than the sum of photoautotrophy and heterotrophy in many microalgal species. Thus, it has been applied to biodiesel production and wastewater utilization. However, its carbon and energy metabolic mechanism is currently poorly understood.
RESULTS: To elucidate underlying carbon and energy metabolic mechanism of mixotrophy, Chromochloris zofingiensis was employed in the present study. Photosynthesis and glucose metabolism were found to operate in a dynamic balance during mixotrophic cultivation, the enhancement of one led to the lowering of the other. Furthermore, compared with photoautotrophy, non-photochemical quenching and photorespiration, considered by many as energy dissipation processes, were significantly reduced under mixotrophy. Comparative transcriptome analysis suggested that the intermediates of glycolysis could directly enter the chloroplast and replace RuBisCO-fixed CO 2 to provide carbon sources for chloroplast organic carbon metabolism under mixotrophy. Therefore, the photosynthesis rate-limiting enzyme, RuBisCO, was skipped, allowing for more efficient utilization of photoreaction-derived energy. Besides, compared with heterotrophy, photoreaction-derived ATP reduced the need for TCA-derived ATP, so the glucose decomposition was reduced, which led to higher biomass yield on glucose. Based on these results, a mixotrophic metabolic mechanism was identified.CONCLUSIONS: Our results demonstrate that the intermediates of glycolysis could directly enter the chloroplast and replace RuBisCO-fixed CO 2 to provide carbon for photosynthesis in mixotrophy. Therefore, the photosynthesis rate-limiting enzyme, RuBisCO, was skipped in mixotrophy, which could reduce energy waste of photosynthesis while promote cell growth. This finding provides a foundation for future studies on mixotrophic biomass production and photosynthetic metabolism.

Isoprostanoid Profiling of Marine Microalgae

Autor: Claire Vigor
Biomolecules. 2020 Jul 18;10(7):1073.

ABSTRACT
Algae result from a complex evolutionary history that shapes their metabolic network. For example, these organisms can synthesize different polyunsaturated fatty acids, such as those found in land plants and oily fish. Due to the presence of numerous double-bonds, such molecules can be oxidized nonenzymatically, and this results in the biosynthesis of high-value bioactive metabolites named isoprostanoids. So far, there have been only a few studies reporting isoprostanoid productions in algae. To fill this gap, the current investigation aimed at profiling isoprostanoids by liquid chromatography - mass spectrometry/mass spectrometry (LC-MS/MS) in four marine microalgae. A good correlation was observed between the most abundant polyunsaturated fatty acids (PUFAs) produced by the investigated microalgal species and their isoprostanoid profiles. No significant variations in the content of oxidized derivatives were observed for Rhodomonas salina and Chaetoceros gracilis under copper stress, whereas increases in the production of C18-, C20- and C22-derived isoprostanoids were monitored in Tisochrysis lutea and Phaeodactylum tricornutum. In the presence of hydrogen peroxide, no significant changes were observed for C. gracilis and for T. lutea, while variations were monitored for the other two algae. This study paves the way to further studying the physiological roles of isoprostanoids in marine microalgae and exploring these organisms as bioresources for isoprostanoid production.

Marine microorganisms as an untapped source of bioactive compounds

Autor: Fuad Ameen

Saudi J Biol Sci. 2021 Jan;28(1):224-231.

ABSTRACT
The search for novel biologically active molecules has extended to the screening of organisms associated with less explored environments. In this sense, Oceans, which cover nearly the 67% of the globe, are interesting ecosystems characterized by a high biodiversity that is worth being explored. As such, marine microorganisms are highly interesting as promising sources of new bioactive compounds of potential value to humans. Some of these microorganisms are able to survive in extreme marine environments and, as a result, they produce complex molecules with unique biological interesting properties for a wide variety of industrial and biotechnological applications. Thus, different marine microorganisms (fungi, myxomycetes, bacteria, and microalgae) producing compounds with antioxidant, antibacterial, apoptotic, antitumoral and antiviral activities have been already isolated. This review compiles and discusses the discovery of bioactive molecules from marine microorganisms reported from 2018 onwards. Moreover, it highlights the huge potential of marine microorganisms for obtaining highly valuable bioactive compounds.

Microalgae n-3 PUFAs Production and Use in Food and Feed Industries

Autor: Marine Remize
Mar Drugs. 2021 Feb 18;19(2):113.

ABSTRACT
N-3 polyunsaturated fatty acids (n-3 PUFAs), and especially eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), are essential compounds for human health. They have been proven to act positively on a panel of diseases and have interesting anti-oxidative, anti-inflammatory or anti-cancer properties. For these reasons, they are receiving more and more attention in recent years, especially future food or feed development. EPA and DHA come mainly from marine sources like fish or seaweed. Unfortunately, due to global warming, these compounds are becoming scarce for humans because of overfishing and stock reduction. Although increasing in recent years, aquaculture appears insufficient to meet the increasing requirements of these healthy molecules for humans. One alternative resides in the cultivation of microalgae, the initial producers of EPA and DHA. They are also rich in biochemicals with interesting properties. After defining macro and microalgae, this review synthesizes the current knowledge on n-3 PUFAs regarding health benefits and the challenges surrounding their supply within the environmental context. Microalgae n-3 PUFA production is examined and its synthesis pathways are discussed. Finally, the use of EPA and DHA in food and feed is investigated. This work aims to define better the issues surrounding n-3 PUFA production and supply and the potential of microalgae as a sustainable source of compounds to enhance the food and feed of the future.

Microalgae-blend tilapia feed eliminates fishmeal and fish oil, improves growth, and is cost Viable

Autor: Pallab K Sarker
Sci Rep. 2020 Nov 12;10(1):19328.

ABSTRACT
Aquafeed manufacturers have reduced, but not fully eliminated, fishmeal and fish oil and are seeking cost competitive replacements. We combined two commercially available microalgae, to produce a high-performing fish-free feed for Nile tilapia (Oreochromis niloticus)-the world's second largest group of farmed fish. We substituted protein-rich defatted biomass of Nannochloropsis oculata (leftover after oil extraction for nutraceuticals) for fishmeal and whole cells of docosahexaenoic acid (DHA)-rich Schizochytrium sp. as substitute for fish oil. We found significantly better ($p < 0.05$) growth, weight gain, specific growth rate, and best (but not significantly different) feed conversion ratio using the fish-free feed compared with the reference diet. Fish-free feed also yielded higher ($p < 0.05$) fillet lipid, DHA, and protein content (but not significantly different). Furthermore, fish-free feed had the highest degree of in-vitro protein hydrolysis and protein digestibility. The median economic conversion ratio of the fish-free feed ($0.95/kg tilapia) was less than the reference diet ($1.03/kg tilapia), though the median feed cost ($0.68/kg feed) was slightly greater than that of the reference feed ($0.64/kg feed) ($p < 0.05$). Our work is a step toward eliminating reliance on fishmeal and fish oil with evidence of a cost-competitive microalgae-based tilapia feed that improves growth metrics and the nutritional quality of farmed fish.

Microorganisms: A Potential Source of Bioactive Molecules for Antioxidant Applications

Autor: Alka Rani
Molecules. 2021 Feb 20;26(4):1142.

ABSTRACT
Oxidative stress originates from an elevated intracellular level of free oxygen radicals that cause lipid peroxidation, protein denaturation, DNA hydroxylation, and apoptosis, ultimately impairing cell viability. Antioxidants scavenge free radicals and reduce oxidative stress, which further helps to prevent cellular damage. Medicinal plants, fruits, and spices are the primarysources of antioxidants from time immemorial. In contrast to plants, microorganisms can be used as a source of antioxidants with the advantage of fast growth under controlled conditions. Further, microbe-based antioxidants are nontoxic, noncarcinogenic, and biodegradable as compared to synthetic antioxidants. The present review aims to summarize the current state of the research on the antioxidant activity of microorganisms including actinomycetes, bacteria, fungi, protozoa, microalgae, and yeast, which produce a variety of antioxidant compounds, i.e., carotenoids, polyphenols, vitamins, and sterol, etc. Special emphasis is given to the mechanisms and signaling pathways followed by antioxidants to scavenge Reactive Oxygen Species (ROS), especially for those antioxidant compounds that have been scarcely investigated so far.

Natural Pigments and Biogas Recovery from Microalgae Grown in Wastewater

Autor: Larissa T Arashiro
ACS Sustain Chem Eng. 2020 Jul 27;8(29):10691-10701

ABSTRACT
This study assessed the recovery of natural pigments (phycobiliproteins) and bioenergy (biogas) from microalgae grown in wastewater. A consortium of microalgae, mainly composed by Nostoc, Phormidium, and Geitlerinema, known to have high phycobiliproteins content, was grown in photobioreactors. The growth medium was composed by secondary effluent from a high rate algal pond (HRAP) along with the anaerobic digestion centrate, which aimed to enhance the N/P ratio, given the lack of nutrients in the secondary effluent. Additionally, the centrate is still a challenging anaerobic digestion residue since the high nitrogen concentrations have to be removed before disposal. Removal efficiencies up to 52% of COD, 86% of NH 4 + -N, and 100% of phosphorus were observed. The biomass composition was monitored over the experimental period in order to ensure stable cyanobacterial dominance in the mixed culture. Phycocyanin and phycoerythrin were extracted from harvested biomass, achieving maximum concentrations of 20.1 and 8.1 mg/g dry weight, respectively. The residual biomass from phycobiliproteins extraction was then used to produce biogas, with final methane yields ranging from 159 to 199 mL CH 4 /g VS. According to the results, by combining the extraction of pigments and the production of biogas from residual biomass, we would not only obtain high-value compounds, but also more energy (around 5-10% higher), as compared to the single recovery of biogas. The proposed process poses an example of resource recovery from biomass grown in wastewater, moving toward a circular bioeconomy.

Optimization of Lutein Recovery from Tetraselmis suecica by Response Surface Methodology

Autor: Kang Hyun Lee
Biomolecules. 2021 Jan 28;11(2):182.

ABSTRACT
Microalgae have been attracting attention as feedstock for biorefinery because they have various advantages, such as carbon fixation, high growth rate and high energy yield. The bioactive compounds and lutein contained in microalgae are known to be beneficial for human health, especially eye and brain health. In this study, in order to improve the recovery of bioactive extracts including lutein from Tetraselmis suecica with higher efficiency, an effective solvent was selected, and the extraction parameters such as temperature, time and solid loading were optimized by response surface methodology.
The most effective solvent for lutein recovery was identified as 100% methanol, and the optimum condition was determined (42.4 °C, 4.0 h and 125 g/L biomass loading) by calculation of the multiple regression model. The maximum content of recovered lutein was found to be 2.79 mg/mL, and the ABTS radical scavenging activity (IC 50) and ferric reducing antioxidant power (FRAP) value were about 3.36 mg/mL and 561.9 μmol/L, respectively. Finally, the

maximum lutein recovery from T. suecica through statistical optimization was estimated to be 22.3 mg/g biomass, which was 3.1-fold improved compared to the control group.

Optimization of growing conditions for pigments production from microalga Navicula incerta using response surface methodology and its antioxidant capacity

Autor: Ricardo Iván González-Vega
Saudi J Biol Sci. 2021 Feb;28(2):1401-1416.

ABSTRACT
Navicula incerta is a marine microalga distributed in Baja California, México, commonly used in aquaculture nutrition, andhas been extended to human food, biomedical, and pharmaceutical industries due to its high biological activity. Therefore, the study aimed to optimize culture conditions to produce antioxidant pigments. A central composite experimental design and response surface methodology (RSM) was employed to analyze the best culture conditions. The medium (nitrogen- deficient concentrations), salinity (PSU = Practical Salinity Unity [g/kg]), age of culture (days), and solvent extraction (ethanol, methanol, and acetone) were the factors used for the experiment. Chlorophyll a (Chl a) and total carotenoids (T- Car), determined spectroscopically, were used as the response variables. The antioxidant capacity was evaluated by DPPH • and ABTS •+ radical inhibition, FRAP, and anti-hemolytic activity. According to the overlay plots, the optimum growth conditions for Chl a and T-Car production were the following conditions: medium = 0.44 mol·L -1 of NaNO 3 , salinity = 40 PSU, age of culture: 3.5 days, and solvent = methanol. The pigment extracts obtained in these optimized conditions had high antioxidant activity in ABTS •+ (86.2-92.1% of inhibition) and anti-hemolytic activity (81.8-96.7% of hemolysis inhibition). Low inhibition (33-35%) was observed in DPPH • . The highest value of FRAP (766.03 ± 16.62 µmol TE/g) was observed in the acetonic extract. The results demonstrated that RSM could obtain an extract with high antioxidant capacity with potential applications in the biomedical and pharmaceutical industry, which encourages the use of natural resources for chemoprevention of chronic-degenerative pathologies.

Production of algal biomass production and high-value compounds mediated by the interaction of microalgal Oocystis sp. KNUA044 and bacterium Sphingomonas KNU100

Autor: Ho Na
J Microbiol Biotechnol. 2020 Dec 14.

ABSTRACT
There is growing interest in the production of microalgae-based high-value by-products as an emerging green biotechnology. However, a cultivation platform for Oocystis sp. has yet to be established. To overcome this limitation, we examined the effect of bacterial culture additions on the growth and production of valuable compounds the Oocystis sp. KNUA044 microalgal strain isolated from a locally adapted region in Korea. This microalgal strain grew only in the presence of a clear supernatant of Sphingomonas sp. KNU100 culture solution and generated 28.57 mg/L/d of biomass productivity.
Protein content (43.9 wt%) was approximately two-fold higher than carbohydrate content (29.4 wt%) and lipid content (13.9 wt%). Among monosaccharides, the microalgal strain produced fucose (33 µg/mg and 0.94 mg/L/d), which has not been reported to date. Fatty acid profiling showed high accumulation of polyunsaturated fatty acids (PUFAs; over 60%) compared to saturated (29.4%) and monounsaturated fatty acids (9.9%) under the same culture conditions. Of these PUFAs, the algal strain produced the highest concentration of linolenic acid (C18:3 ω3; 40.2%) in the omega-3 family and generated eicosapentaenoic acid (C20:5 ω3; 6.0%), better known as EPA. Based on these results, we suggest that the application of a Sphingomonas sp. KNU100 strain-dependent culture for cultivation of Oocystis sp. KNUA044 is a promising future bioprocess for increasing algal biomass and high-value bioactive by-products, including fucose and PUFAs such as linolenic acid and EPA.

Pulsed Electric Fields-Assisted Extraction of Valuable Compounds From Arthrospira Platensis: Effect of Pulse Polarity and Mild Heating

Autor: Daniele Carullo

Front Bioeng Biotechnol. 2020 Sep 4;8:551272.

ABSTRACT
The present study aimed to investigate the effect of the main pulsed electric field (PEF) process parameters on the cell damages of A. platensis microalgae and the extractability of valuable compounds [water-soluble proteins (WSP), C- phycocyanin (C-PC), and carbohydrates (CH)]. Aqueous microalgae suspensions (2%, w/w) were PEF-treated at variable field strength (E = 10, 20, 30 kV/cm), total specific energy (W T = 20, 60, 100 kJ/kg susp), and inlet temperature (25, 35, 45°C), with either monopolar or bipolar square wave pulses (5 μs of width, delay time between pulses of opposite polarities = 1, 5, 10, 20 μs), prior to extraction with water at room temperature (25°C) for up to 3 h. High-pressure homogenization (HPH) treatment (P = 150 MPa, 3 passes) was used to achieve complete cell disruption to quantify the total extractable content of target intracellular compounds. Scanning electron microscopy (SEM) and optical microscopy analyses clearly showed that PEF merely electroporated the membranes of algae cell, without damaging the cell structure and forming cell debris. The application of PEF treatment (monopolar pulses, 20 kV/cm and 100 kJ/kg susp) at room temperature significantly enhanced the extraction yield of WSP [17.4% dry weight (DW)], CH (10.1% DW), and C-PC (2.1% DW), in comparison with the untreated samples. Bipolar pulses appeared less effective than monopolar pulses and led to extraction yields dependent on the delay time. Additionally, regardless of pulse polarity, a clear synergistic effect of the combined PEF (20 kV/cm and 100 kJ/kg susp)-temperature (35°C) treatment was detected, which enabled the extraction of up to 37.4% (w/w) of total WSP, 73.8% of total CH, and 73.7% of total C-PC. Remarkably, the PEF treatment enabled to obtain C-phycocyanin extractwith higher purity than that obtained using HPH treatment. The results obtained in this work suggest that the application of PEF combined with mild heating could represent a suitable approach for the efficient recovery of water-soluble compounds microalgal biomass.

Rapid Manipulation in Irradiance Induces Oxidative Free-Radical Release in a Fast-Ice Algal Community (McMurdo Sound, Antarctica)

Autor: Fraser Kennedy
Front Plant Sci. 2020 Nov 25;11:588005.

ABSTRACT
Sea ice supports a unique assemblage of microorganisms that underpin Antarctic coastal food-webs, but reduced ice thickness coupled with increased snow cover will modify energy flow and could lead to photodamage in ice-associated microalgae. In this study, microsensors were used to examine the influence of rapid shifts in irradiance on extracellular oxidative free radicals produced by sea-ice algae. Bottom-ice algal communities were exposed to one of three levels of incident light for 10 days: low (0.5 μmol photons m -2 s -1 , 30 cm snow cover), mid-range (5 μmol photons m -2 s -1 , 10 cm snow), or high light (13 μmol photons m -2 s -1 , no snow). After 10 days, the snow cover was reversed (either removed or added), resulting in a rapid change in irradiance at the ice-water interface. In treatments acclimated to low light, the subsequent exposure to high irradiance resulted in a ~400× increase in the production of hydrogen peroxide (H 2 O 2) and a 10× increase in nitric oxide (NO) concentration after 24 h. The observed increase in oxidative free radicals also resulted in significant changes in photosynthetic electron flow, RNA-oxidative damage, and community structural dynamics. In contrast, there was no significant response in sea-ice algae acclimated to high light and then exposed to a significantly lower irradiance at either 24 or 72 h. Our results demonstrate that microsensors can be used to track real-time in-situ stress in sea-ice microbial communities. Extrapolating to ecologically relevant spatiotemporal scales remains a significant challenge, but this approach offers a fundamentally enhanced level of resolution for quantifying the microbial response to global change.

Rapid analytical methods for the microalgal and cyanobacterial biorefinery: Application on strains of industrial importance

Autor: Joseph S Palmer
Microbiologyopen. 2021 Jan;10(1):e1156.

ABSTRACT
To realize the potential of microalgae in the biorefinery context, exploitation of multiple products is necessary for profitability and bioproduct valorization. Appropriate analytical tools are required for growth optimization, culture monitoring, and quality control purposes, with safe, low-tech, and low-cost solutions favorable. Rapid, high-throughput, and user-friendly methodologies were devised for (a) determination of phycobiliproteins, chlorophylls, carotenoids, proteins, carbohydrates , and lipids and (b) qualitative and quantitative carotenoid profiling using UPLC-PDA-MS E . The complementary methods were applied on 11 commercially

important microalgal strains including prasinophytes, haptophytes, and cyanobacteria, highlighting the suitability of some strains for coproduct exploitation and the method utility for research and industrial biotechnology applications. The UPLC method allowed separation of 41 different carotenoid compounds in <15 min. Simple techniques are described for further quantification and comparison of pigment profiles, allowing for easy strain selection and optimization for pigment production, with suitability for biotechnological or biomedical applications.

Removal of Nitrogen and Phosphorus from Thickening Effluent of an Urban Wastewater Treatment Plant by an Isolated Green Microalga

Autor: Costanza Baldisserotto
Plants (Basel). 2020 Dec 18;9(12):1802.

ABSTRACT
Microalgae are photosynthetic microorganisms and are considered excellent candidates for a wide range of biotechnological applications, including the removal of nutrients from urban wastewaters, which they can recover and convert into biomass. Microalgae-based systems can be integrated into conventional urban wastewater treatment plants(WW-TP) to improve the water depuration process. However, microalgal strain selection represents a crucial step for effective phytoremediation. In this work, a microalga isolated from the effluent derived from the thickening stage of waste sludge of an urban WW-TP was selected and tested to highlight its potential for nutrient removal. Ammonium and phosphate abatements by microalgae were evaluated using both the effluent and a synthetic medium in a comparative approach. Parallelly, the isolate was characterized in terms of growth capability, morphology, photosynthetic pigment content and photosystem II maximum quantum yield. The isolated microalga showed surprisingly high biomass yield and removal efficiency of both ammonium and phosphate ions from the effluent but not from the synthetic medium. This suggests its clear preference to grow in the effluent, linked to the overall characteristics of this matrix. Moreover, biomass from microalgae cultivated in wastewater was enriched in photosynthetic pigments, polyphosphates, proteins and starch, but not lipids, suggesting its possible use as a biofertilizer.

Skin Pigmentation in Gilthead Seabream (Sparus aurata L.) Fed Conventional and Novel Protein Sources in Diets Deprived of Fish Meal

Autor: Domitilla Pulcini
Animals (Basel). 2020 Nov 17;10(11):2138.

ABSTRACT
The pattern of yellowish pigmentation of the skin was assessed in gilthead seabream (Sparus aurata) fed for 12 weeks iso-proteic (45%) and iso-lipidic (20%) diets deprived of fish meal and containing either a blend of vegetable protein-rich ingredients or where graded levels of the vegetable protein blend were replaced by insect (Hermetia illucens-10%, 20% or 40%) pupae meal, poultry by-product meal (20%, 30% or 40%), red swamp crayfish meal (10%) and marine microalgae (Tisochrysis lutea and Tetraselmis suecica-10%) dried biomass. Digital images of fish fed diets differing in protein sources were analyzed by means of an automatic and non-invasive image analysis tool, in order to determine the number of yellow pixels and their dispersion on the frontal and lateral sides of the fish. The relationship between the total carotenoid concentration in the diet and the number of yellow pixels was investigated. Test diets differently affected gilthead seabream skin pigmentation both in the forefront and the operculum, due to their carotenoid content. The highest yellow pixels' number was observed with the diet containing microalgae. Fish fed poultry by-product meal were characterized by the lowest yellow pixels' number, diets containing insect meal had an intermediate coloring capacity. The vegetable control, the microalgae mix diet and the crayfish diet had significantly higher values of yellow pixels at both inspected skin sites.

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.

ABSTRACT
This study evaluates the techno-economic feasibility of five solar-powered concepts for the production of autotrophicmicroorganisms 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 H 2 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 H 2 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.

Study of Morphological Features and Determination of the Fatty Acid Composition of the Microalgae Lipid Complex

Autor: Vyacheslav Dolganyuk
Biomolecules. 2020 Nov 19;10(11):1571.

ABSTRACT
Microalgae are rich in nutrients and biologically active substances such as proteins, carbohydrates, lipids, vitamins, pigments, phycobiliproteins, among others. The lipid composition of the microalgae Chlorella vulgaris, Arthrospira platensis, and Dunaliella salina was screened for the first time. The proposed method for purifying the lipid complex isolated from microalgae's biomass involved dissolving the lipid-pigment complex in n-hexane for 4 h and stirring at 500 rpm. We found that the largest number of neutral lipids is contained in the biomass of microalgae Arthrospira platensis, fatty acids, polar lipids (glycerophospholipids), and unsaponifiable substances-in the biomass of microalgae Dunaliella salina, chlorophyll, and other impurities-in the biomass of microalgae Chlorella vulgaris. The developed method of purification of the fatty acid composition of the microalgae lipid complex confirmed the content of fatty acids in microalgae, which are of interest for practical use in the production of biologically active components. We also determined the potential of its use in the development of affordable technology for processing microalgae into valuable food and feed additives.

Temperature-Dependent Lipid Accumulation in the Polar Marine Microalga Chlamydomonas malina RCC2488

Autor: Daniela Morales-Sánchez
Front Plant Sci. 2020 Dec 23;11:619064.

ABSTRACT
The exploration of cold-adapted microalgae offers a wide range of biotechnological applications that can be used for human, animal, and environmental benefits in colder climates. Previously, when the polar marine microalga Chlamydomonas malina RCC2488 was cultivated under both nitrogen replete and depleted conditions at 8°C, it accumulated lipids and carbohydrates (up to 32 and 49%, respectively), while protein synthesis decreased (up to 15%). We hypothesized that the cultivation temperature had a more significant impact on lipid accumulation than the nitrogen availability in C. malina. Lipid accumulation was tested at three different temperatures, 4, 8, and 15°C, under nitrogen replete and depleted conditions.
At 4°C under the nitrogen replete condition C. malina had the maximal biomass productivity (701.6 mg L -1 day -1). At this condition, protein content was higher than lipids and carbohydrates. The lipid fraction was mainly composed of polyunsaturated fatty acids (PUFA) in the polar lipid portion, achieving the highest PUFA productivity (122.5 mg L -1 day -1).
At this temperature, under nitrogen deficiency, the accumulation of carbohydrates and neutral lipids was stimulated. At 8 and 15°C, under both nitrogen replete and depleted conditions, the lipid and carbohydrate content were higher than at 4°C, and the nitrogen stress condition did not affect the algal biochemical composition. These results suggest that C. malina is a polar marine microalga with a favorable growth temperature at 4°C and is stressed at temperatures ≥8°C, which directs the metabolism to the synthesis of lipids and carbohydrates. Nevertheless, C. malina RCC2488 is a microalga suitable for PUFA production at low temperatures with biomass productivities comparable with mesophilic strains.

Tetraedron minimum, First Reported Member of Hydrodictyaceae to Accumulate Secondary Carotenoids

Autor: Philipp Doppler
Life (Basel). 2021 Jan 30;11(2):107.

ABSTRACT
We isolated a novel strain of the microalga Tetraedron minimum in Iceland from a terrestrial habitat. During long-term cultivation, a dish culture turned orange, indicating the presence of secondary pigments. Thus, we characterized T.minimum for growth and possible carotenoid production in different inorganic media. In a lab-scale photobioreactor, we confirmed that nitrogen starvation in combination with salt stress triggered a secondary carotenoid accumulation. The development of the pigment composition and the antioxidant capacity of the extracts was analyzed throughout the cultivations. The final secondary carotenoid composition was, on average, 61.1% astaxanthin and 38.9% adonixanthin.
Moreover, the cells accumulated approx. 83.1% unsaturated fatty acids. This work presents the first report of the formation of secondary carotenoids within the family Hydrodictyaceae (Sphaeropleales, Chlorophyta).

Transcription Factor ChbZIP1 from Alkaliphilic Microalgae Chlorella sp. BLD Enhancing Alkaline Tolerance in Transgenic Arabidopsis thaliana

Autor: Dehui Qu
Int J Mol Sci. 2021 Feb 27;22(5):2387.

ABSTRACT
Saline-alkali soil has become an important environmental problem for crop productivity. One of the most effective approaches is to cultivate new stress-tolerant plants through genetic engineering. Through RNA-seq analysis and RT-PCR validation, a novel bZIP transcription factor ChbZIP1, which is significantly upregulated at alkali conditions, was obtained from alkaliphilic microalgae Chlorella sp. BLD. Overexpression of ChbZIP1 in Saccharomyces cerevisiae and Arabidopsis increased their alkali resistance, indicating ChbZIP1 may play important roles in alkali stress response. Through subcellular localization and transcriptional activation activity analyses, we found that ChbZIP1 is a nuclear-localized bZIP TF with transactivation activity to bind with the motif of G-box 2 (TGACGT). Functional analysis found that genes such as GPX1, DOX1, CAT2, and EMB, which contained G-box 2 and were associated with oxidative stress, were significantly upregulated in Arabidopsis with ChbZIP1 overexpression. The antioxidant ability was also enhanced in transgenic Arabidopsis. These results indicate that ChbZIP1 might mediate plant adaptation to alkali stress through the active oxygen detoxification pathway. Thus, ChbZIP1 may contribute to genetically improving plants' tolerance to alkali stress.

Understanding the toxicity effect and mineralization efficiency of in-situ electrogenerated chlorine dioxide for the treatment of priority pollutants of coking wastewater

Autor: Hariraj Singh
Ecotoxicol Environ Saf. 2021 Mar 15;211:111907.

ABSTRACT
Oxidation of phenol, cyanide and aniline have been analyzed by the enhanced electro-oxidation process in which sodium chlorite was used as an electrolyte and results were validated using statistical tool based on Box-Behnken design. The mineralization efficiency of 78.4%, and 98.18% were predicted at optimized variables condition for phenol, and aniline respectively, whereas complete mineralization has been observed for the cyanide at the optimized conditions, which describes the significance of the design model approach.The process mineralizes the higher phenol concentration revealing a drastic reduction in power consumption in comparison of direct oxidation, i.e., 799.36 kWh/kg to 138.18 kWh/kg for more than 90% mineralization of phenol even at a higher current density of 13.63 mA/cm 2 . The kinetic modelling approach justified that higher current density has also played a role in higher mineralization of pollutants at the specific operating conditions. The by-product formation and toxicity effect on microalgae in wastewater were assessed by the full scan mass spectrometry and microalgae pigment inhibition test after the electro-oxidation of coking wastewater. The pigment growth inhibition rate of Chlorella sp. NCQ and Micractinium sp. NCS2 suggests that sodium chlorite as an electrolyte aid can also effectively used as an oxidizing agent and algal inhibiter in the coking wastewater.

Unlocking the genomic potential of aerobes and phototrophs for the production of nutritious and palatable microbial food without arable land or fossil fuels

Autor: Abbas Alloul
Microb Biotechnol. 2021 Feb 2.

ABSTRACT
The increasing world population and living standards urgently necessitate the transition towards a sustainable food system. One solution is microbial protein, i.e. using microbial biomass as alternative protein source for human nutrition, particularly based on renewable electron and carbon sources that do not require arable land. Upcoming green electrification and carbon capture initiatives enable this, yielding new routes to H2, CO2 and CO2-derived compounds like methane, methanol, formic- and acetic acid. Aerobic hydrogenotrophs, methylotrophs, acetotrophs and microalgae are the usual suspects for nutritious and palatable biomass production on these compounds. Interestingly, these compounds are largely un(der)explored for purple non-sulfur bacteria, even though these microbes may be suitable for growing aerobically and phototrophically on these substrates. Currently, selecting the best strains, metabolisms and cultivation conditions for nutritious and palatable microbial food mainly starts from empirical growth experiments, and mostly does not stretch beyond bulk protein. We propose a more target-driven and efficient approach starting from the genome-embedded potential to tuning towards, for instance, essential amino- and fatty acids, vitamins, taste. Genome-scale metabolic models combined with flux balance analysis will facilitate this, narrowing down experimental variations and enabling to get the most out of the 'best' combinations of strain and electron and carbon sources.

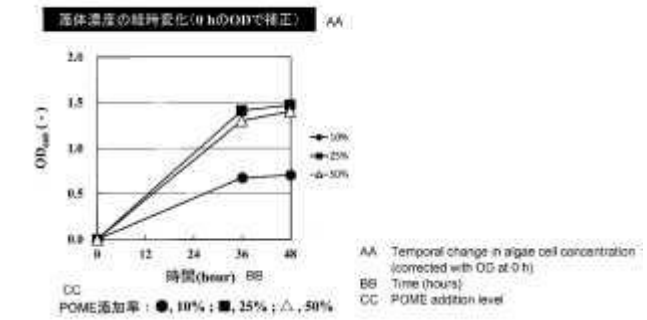
PATENTES

CULTURE METHOD OF HETEROTROPHIC MICROALGAE AND DHA PRODUCTION METHOD USING PALM OIL MILL EFFLUENT (POME)

Page bookmark	JP2020054391 (A) - CULTURE METHOD OF HETEROTROPHIC MICROALGAE AND DHA PRODUCT USING PALM OIL MILL EFFLUENT (POME)
Inventor(s):	TADA KIYOSHI; WATANABE MAKOTO; YOSHIDA MASAKI; ITO JUNKO; NAKAJIMA TOSHIHID MICHAEL +
Applicant(s):	MOBIOL CORP +
Application number:	JP20200003760 20200114 Global Dossier

To provide culture methods that can efficiently grow microalgae using POME discharged from palm oil manufacturing process, and to provide methods for efficiently producing high value-added valuables from microalgae.SOLUTION: By culturing heterotrophic microalgae that produce ω-3 polyunsaturated fatty acids such as DHA (docosahexaenoic acid) using POME, these heterotrophic microalgae are efficiently grown and DHA is produced at a high

concentration.SELECTED DRAWING: Figure 1



Device for simply, conveniently and efficiently preparing hydrogen-rich water

Page bookmark	CN211170036 (U) - Device for simply, conveniently and efficiently preparing hydrogen-rich wat
Inventor(s):	CHEN MEI +
Applicant(s):	BEIJING QUELIN MAITIAN TECH DEVELOPMENT CO LTD +
Application number:	CN201921591583U 20190924

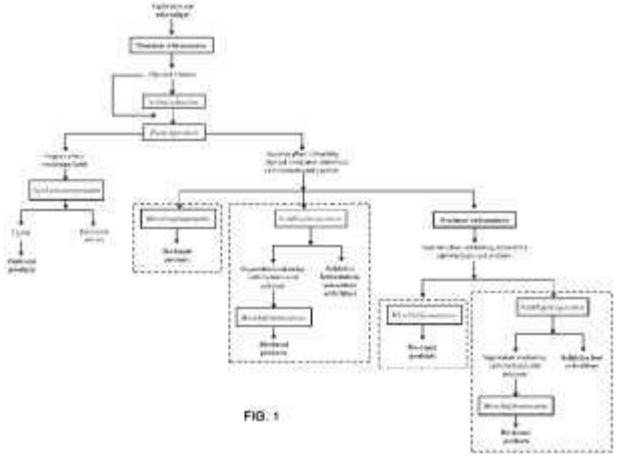
The utility model provides a device for simply, conveniently and efficiently preparing hydrogen-rich water. The system comprises a microalgae photosynthetic hydrogen production system, a drainage andgas collection system and a hydrogen-rich water collection system which are sequentially connected through sterile conduits, wherein a microalgae culture solution formed by a photosynthetic microalgaecell suspension and a sulfur-deficient TAP culture solution is placed in the microalgae culture bottle. According to the device for preparing the hydrogen-rich water, hydrogen can be generated by utilizing photosynthetic microalgae through solar energy, and the hydrogen-rich water can be prepared at the same time. Compared with a hydrogen-rich water preparation device existing in the market, thehydrogen-rich water preparation device has the advantages of simplicity, convenience, economy, cleanness and high efficiency.

ENZYMATIC DIGESTION OF MICROALGAE FOR LIPID, SUGAR AND PROTEIN RECOVERY

Page bookmark	JP2020010713 (A) - ENZYMATIC DIGESTION OF MICROALGAE FOR LIPID, SUGAR AND PRO
Inventor(s):	AGASTESWAR VADLAMANI; PATRICIA RELUE; SRIDHAR VIAMAJALA; SHAO HENG; SASIDHA
Applicant(s):	UNIV TOLEDO +
Application number:	JP20190174003 20190925 Global Dossier

To provide cost-efficient processes for recovery of lipids, sugars and proteins from microbial biomass by enzymatic digestion.SOLUTION: A method of enzymatic hydrolysis comprises: treating microalgae with enzymes to produce digested biomass, where the enzymes comprise a mixture of at least one protease and at least one amylase; and separating the digested biomass into an organic phase and an aqueous phase, where the organic phase contains lipids and the

aqueous phase contains solids, carbohydrates and peptides.SELECTED DRAWING: Figure 1



GREEN ALGAL VARIANT WITH REDUCED CHLOROPHYLL CONTENT AND INCREASED OIL AND FAT PRODUCTIVITY, AND USE THEREOF

Page bookmark	JP2020096583 (A) - GREEN ALGAL VARIANT WITH REDUCED CHLOROPHYLL CONTENT AND INCREASED OIL AND FAT PRODUCTIVITY, AND USE THEREOF
Inventor(s):	HARAYAMA SHIGEAKI; HAYAKAWA JUNPEI; IDE YOKO +
Applicant(s):	UNIV CHUO; DENSO CORP +
Priority number(s):	JP20180209358 20181107

To provide eukaryotic microalgae having improved oil and fat productivity.SOLUTION: Provided is an eukaryotic microalgal variant that has an amino acid sequence having at least 80% sequence identity with each of the conserved regions of B-type response regulator protein having a particular amino acid and has reduced activity of proteins having B-type response regulator activity, the eukaryotic microalgal variant having one or more selected from the group consisting of: (i) reducing chlorophyll content rate; (ii) increasing chlorophyll a/b ratio; (iii) being strong light resistant; (iv) increasing biomass productivity; (v) increasing oil and fat content; and (vi) increasing fat productivity, compared to the parent strain.SELECTED DRAWING: Figure 1

High-temperature hydrogen production and microalgae oil production coupling capacity method

Page bookmark	CN111763694 (A) - High-temperature hydrogen production and microalgae oil production coup method
Inventor(s):	LIU BINGFENG; YIN TIANMING; DU JIAN; CAO GUANGLI; XIE GUOJUN; XING DEFENG +
Applicant(s):	HARBIN INST TECHNOLOGY +
Application number:	CN201910313864 20190418 Global Dossier

The invention discloses a high-temperature hydrogen production and microalgae oil production coupling capacity method, and belongs to the technical field of biological energy. The method

comprises thestep of introducing wastewater into a CSTR anaerobic reactor, inoculating secondary sedimentation tank sludge subjected to high-temperature domestication culture to carry out a continuous high-temperature hydrogen production reaction, and continuously conveying a fermentation liquor separated by the CSTR anaerobic reactor into a microalgae growth reactor during the high-temperature hydrogen production reaction, continuously conveying carbon dioxide and hydrogen generated in a high-temperature hydrogen production reactor to a position below the liquid level of the fermentation liquor in the microalgae growth reactor, after continuously introducing a fermentation product generated in the high-temperature hydrogen production reactor into the microalgae growth reactor for one day, inoculating microalgae into the microalgae growth reactor, and culturing the microalgae; and then conveying the cultured microalgae fermentation liquor into a microalgae oil production reactor for circular oil production culture, collecting microalgae subjected to oil production culture, collecting hydrogen, and extracting grease in the microalgae. The method can realize continuous flow operation and is suitable for industrial production.

METHOD AND SYSTEM FOR COMPLEX PRODUCTION OF HYDROGEN AND MICROALGAE

Page bookmark	KR102107013 (B1) - METHOD AND SYSTEM FOR COMPLEX PRODUCTION OF HYDROGEN AND M
Inventor(s):	YOO YOUNG DON; KIM SU HYUN; SEO MINHYE; KANG SUNG KYUN; LEE HYUP HEE +
Applicant(s):	INST FOR ADVANCED ENGINEERING [KR]; KOREA INST OCEAN SCI & TECH [KR] +
Application number:	KR20190013913 20190201 Global Dossier

The present invention discloses a method and a system for combined production of hydrogen and microalgae by using marine microorganisms. According to one embodiment of the present invention, a method for combined production of hydrogen and microalgae by using marine microorganisms comprises the steps of: inputting first sea water, carbon monoxide-containing gas and nutrients into a marine microorganism reactor to carry out a predetermined reaction using marine microorganisms; producing hydrogen and carbon dioxide by the reaction using the marine microorganisms; purifying the produced hydrogen and the carbon dioxide and isolating the hydrogen and the carbon dioxide; and inputting the isolated carbon dioxide into the microalgae reactor along with second sea water to culture and produce microalgae.

METHOD FOR PRODUCING METHANE BY MEANS OF ANAEROBIC CODIGESTION OF ALPERUJO (OLIVE OIL BYPRODUCT) AND A MICROALGA

Page bookmark	WO2021130396 (A1) - METHOD FOR PRODUCING METHANE BY MEANS OF ANAEROBIC CODI ALPERUJO (OLIVE OIL BYPRODUCT) AND A MICROALGA
Inventor(s):	RINCÓN LLORENTE BÁRBARA MARÍA [ES]; FERNÁNDEZ RODRÍGUEZ MARIA JOSÉ [ES]; D CALVENTE DAVID [ES]; BORJA PADILLA RAFAEL [ES]; JIMÉNEZ-RODRÍGUEZ ANTONIA [ES] +
Applicant(s):	CONSEJO SUPERIOR INVESTIGACION [ES]; UNIV PABLO DE OLAVIDE [ES] +
Application number:	WO2020ES70775 20201209 Global Dossier

The present invention belongs to the sector for the use of food industry byproducts. In particular, the invention relates to an improved method for producing methane from the anaerobic codigestion of alperujo, the main byproduct generated in olive oil production, and the micro alga Dunaliella salina.

Method For Cultivation of Microalgae Using Water Electrolysis

Page bookmark	KR20200105222 (A) - Method For Cultivation of Microalgae Using Water Electrolysis
Inventor(s):	HAN JONG IN; KIM GA YEONG +
Applicant(s):	KOREA ADVANCED INST SCI & TECH [KR] +
Application number:	KR20190024096 20190228 Global Dossier

The present invention relates to a method for culturing microalgae using a water electrolysis device and, more particularly, to a method for culturing microalgae using water electrolysis, which uses an electrolysis device comprising: a positive electrode; a negative electrode; a negative ion exchange membrane positioned between the positive electrode and the negative electrode; and a pair of a positive electrode chamber and a negative electrode chamber separated by the anion exchange membrane. The method comprises the following steps: lowering the pH of a microalgae culture solution by utilizing hydrogen ions generated from the positive electrode of the electrolysis device, and simultaneously collecting carbon dioxide supplied by utilizing hydroxide ions generated from the negative electrode as bicarbonate ions; and then supplying the collected bicarbonate ions to the positive electrode chamber through the negative ion exchange membrane. According to the present invention, the productivity of biomass can be improved by culturing microalgae with an electrolysis device capable of continuously supplying a carbon source and adjusting the pH of the culture medium. In addition, the bicarbonate ions of the present invention are converted from carbon dioxide, and thus can solve environmental problems and bring economic benefits.

Method for cultivating microalgae with pig farm biogas slurry and making full use of microalgae to produce bio-oil

Page bookmark	CN111500465 (A) - Method for cultivating microalgae with pig farm biogas slurry and makir microalgae to produce bio-oil
Inventor(s):	LI GANG; HUANG ZHIGANG; TIAN BIN; ZHANG JIANG +
Applicant(s):	UNIV BEIJING TECHNOLOGY & BUSINESS +
Application number:	CN202010445229 20200524 Global Dossier

The invention provides a method for culturing microalgae with pig farm biogas slurry and making full use of the microalgae to produce bio-oil. The method comprises the following steps of: preparing a5-20% microalgae culture solution by using the pig farm biogas slurry, and inoculating the microalgae into the culture solution for culturing; grinding the microalgae cultured by the pig farm biogas slurry and quartz sand according to a certain mass ratio, and adding an organic solvent for extraction to realize extraction of microalgae grease and preparation of microalgae residue; carrying out esterification reaction on the microalgae grease to obtain bio-oil; and pyrolyzing the microalgae residue in a cracking device at 300-800DEG C in an atmosphere of inert gas to prepare the bio-oil again.On the basis of the existing pig manure biogas engineering, the pig farm biogas slurry is used for culturing microalgae, so that purification treatment of the pig farm biogas slurry is realized, and alarge amount of biomass energy is accumulated; by adding the additives into the biogas slurry, the growable biomass and grease content of microalgae in the biogas slurry are improved; and through full utilization of the microalgae, the energy utilization potential of the biogas slurry and the microalgae is improved, and the energy problem is relieved to a certain extent.

Method for culturing microalgae by using benzoic acid

Page bookmark	CN111548942 (A) - Method for culturing microalgae by using benzoic acid
Inventor(s):	ZHOU DANDAN; ZHAO ZHENHAO; FU LIANG; CUI XIAOCHUN; LIU YANG +

Applicant(s):	UNIV NORTHEAST +

Application number:	CN202010636378 20200703 Global Dossier

The invention belongs to the technical field of microalgae culture, and particularly relates to a method for culturing microalgae by using benzoic acid. The method comprises the following steps of: adding benzoic acid at the initial stage of the growth regulation period of microalgae, and continuing culture, wherein the addition amount of benzoic acid is 50-2,000 microgram/L. By adopting the method provided by the invention, the biomass of the microalgae is increased by 6.67%-27%, the grease content is improved by 13.65%-45.6%, the content of chlorophyll a is increased by 4.55%-60%, the content of chlorophyll b is increased by 7.14%-71%, especially the content of carotenoid is increased by 31.9%-153%, the protein yield is increased by 26.2%-28.6%, and the saccharide yield is increased by 11.8%-18.2%.

Method for improving alcohol and ester compounds in microalgal bio-oil by using biodiesel by-products

Page bookmark	CN110747065 (A) - Method for improving alcohol and ester compounds in microalgal bio-biodiesel by-products
Inventor(s):	SHANG HAO; WANG SHUANG; MA WENBIAO; JIANG DING; HU YAMIN; QIAN LILI +
Applicant(s):	UNIV JIANGSU +
Application number:	CN20191134468 20191029 Global Dossier

The invention provides a method for improving alcohol and ester compounds in microalgal bio-oil by using biodiesel by-products, and belongs to the field of biomass fuel production and preparation. Themethod includes the following steps that (1) the biodiesel by-products and dried microalgae powder are fully mixed, the biodiesel by-products are by-products after the transesterification reaction iscompleted in the preparation of biodiesel; (2) the mixed sample is put into a pyrolysis furnace to react; and (3) the reaction product is condensed, the condensed product is extracted with an organicsolvent, then the organic solvent is evaporated using a rotary evaporator, and pure bio-oil is obtained. The biodiesel by-products and the microalgae are co-pyrolyzed, the biodiesel by-products can be effectively reused, the processing cost of the biodiesel by-products is saved, meanwhile, the interaction coupling between the two raw materials is verified, the content of nitrogen-containing and sulfur-containing compounds in the bio-oil is reduced, and the quality of the bio-oil is improved.

Method for preparing idesia polycarpa palmitoleic acid by fermenting idesia polycarpa waste liquid with composite microalgae

Page bookmark	CN112553283 (A) - Method for preparing idesia polycarpa palmitoleic acid by fermenting ide waste liquid with composite microalgae
Inventor(s):	ZHANG CHISONG; GAO YUGE; YANG MENGTING; XIAO YUANYUAN; ZHOU HONGLIANG +
Applicant(s):	SICHUAN TAIHONGYUAN AGRICULTURAL GROUP CO LTD +
Application number:	CN202011565058 20201225 Global Dossier

The invention provides a method for preparing idesia polycarpa palmitoleic acid by fermenting idesia polycarpa waste liquid with composite microalgae, and solves the technical problems that

in the prior art, the source of palmitoleic acid is limited and the market demand is difficult to meet. The method comprises the following steps: (1) preparing a culture solution for fermentation from the idesia polycarpa waste liquid; (2) fermenting the composite microalgae; (3) performing wall-breaking extraction; and (4) performing grease separating and purifying to obtain the idesia polycarpa palmitoleic acid and idesia polycarpa docosahexaenoic acid. According to the method, high-oil-yield green ball microalgae is used as a starting strain, the idesia polycarpa waste liquid is used for preparing aculture solution beneficial to growth of the green ball microalgae, and through autotrophy and abnormal combined fermentation, cultured thalli are dried, extracted, separated and purified to obtain the high-purity idesia polycarpa palmitoleic acid and high-purity idesia polycarpa docosahexaenoic acid. The method makes up for the deficiency of palmitoleic acid yield, enlarges the source of the palmitoleic acid, and can better meet the market demands.

Method for promoting microalga growth and oil production by utilizing iron element in flue gas of coal-fired power plant

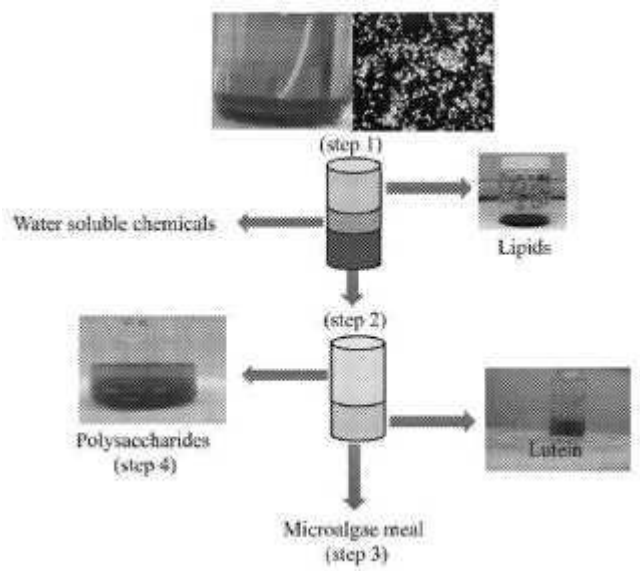
Page bookmark	CN112175836 (A) - Method for promoting microalga growth and oil production by utilizing iro flue gas of coal-fired power plant
Inventor(s):	CHU FEIFEI; CHENG JUN; ZHANG PENGYUE; HOU WEN +
Applicant(s):	UNIV JILIANG CHINA +
Application number:	CN202011100489 20201015 Global Dossier

The invention discloses a method for promoting microalga growth and oil production by using an iron element in flue gas of a coal-fired power plant. The method comprises the following steps of (1) washing and collecting fly ash particles in the flue gas in a microalga culture process; (2) adding hydrochloric acid, and reacting for 1.5-2.5 hours at the temperature of 80-100 DEG C, so that iron oxide particles are converted into ferric ions which can be absorbed and utilized by microalgae; (3) adding a complexing agent into a solution obtained after the reaction in the step (2), thereby converting iron into complexing-state iron; and (4) adding a solution obtained in the step (3) into a microalga culture medium to enable the final mass concentration of the iron element to be 1.0-10.0 mg L<-1>, and culturing the microalgae. According to the method, the iron element in the flue gas is collected, converted and utilized, the oxidation-state iron which cannot be absorbed by the microalgae isconverted into the ionic-state iron, then the complexing agent is added, and the ionic-state iron continues to be converted into the complexing-state iron which is more beneficial to absorption and utilization by the microalgae, so that the improvement of the oil yield and the oil production efficiency of the microalgae can be effectively promoted.

Method of microalgal biomass processing for high-value chemicals production, the resulting composition of butyrogenic algal slowly fermenting dietary fiber, and a way to improve colon health using a slowly fermenting butyrogenic algal dietary fiber

Page bookmark	US2020046003 (A1) - Method of microalgal biomass processing for high-value chemicals produc a way to improve colon health using a slowly fermenting butyrogenic algal dietary fiber
Inventor(s):	BENMOUSSA MUSTAPHA [US] +
Applicant(s):	BENMOUSSA MUSTAPHA [US] +
Application number:	US201916600559 20191013 Global Dossier

A method to process microalgae biomass and produce high-value chemicals from microalgae biomass is disclosed. The method uses the same biomass cells to extract more than one component such as are lipids, water-soluble chemicals, carotenoids, polysaccharides and algae meal. The method is a sequence of physical and chemical treatments. Water soluble polysaccharides produced by the method exhibit properties of low viscosity at low shear thinning. A method for extracting dietary fiber from microalgal biomass is disclosed. Compositions of water-soluble polysaccharides that are fermented slowly by colon microbiota with less gas production than commercial dietary fiber FOS are disclosed. The present inventions described herein provide a method of improving colon health by increasing butyrate during a microalgal dietary fiber fementing process by colonic microbiota.



Method of producing biodiesel from microalgae using thermo-responsive switchable solvent

Page bookmark	US11060120 (B1) - Method of producing biodiesel from microalgae using thermo-responsiv solvent
Inventor(s):	AL-ZUHAIR SULAIMAN ABDULRAZAK [AE]; ISMAIL MUKHTAR AHMED [AE] +
Applicant(s):	UNIV UNITED ARAB EMIRATES [AE] +
Application number:	US202017105465 20201125 Global Dossier

The method for producing biodiesel from microalgae using a thermo-responsive switchable solvent includes mixing a thermo-responsive switchable solvent (TSS) in a hydrophilic state with microalgae at room temperature (25° C.); maintaining the TSS-microalgae mixture in the hydrophilic state for a cell disruption time period; raising the temperature of the TSS-microalgae mixture to switch the TSS solvent to a hydrophobic state; maintaining the TSS solvent in the hydrophobic state in the presence of immobilized lipase catalyst and methanol for an extraction/reaction time period to obtain fatty acid methyl esters (FAMEs) as the oils are extracted; lowering the temperature of the TSS-microalgae mixture to switch the TSS solvent back to the hydrophilic state; and maintaining the TSS solvent in the hydrophilic state for a product separation time period. The method may further include extracting the FAMEs from the TSS-microalgae mixture with a nonpolar organic solvent to obtain the biodiesel product.

Microalgae biomembrane culture method capable of simultaneously improving biomass yield and oil yield

Page bookmark	CN110684667 (A) - Microalgae biomembrane culture method capable of simultaneously impro

	yield and oil yield
Inventor(s):	HUANG YUN; CHEN KEMING; LIAO QIANG; ZHU XUN; XIA AO; ZHU XIANQING +
Applicant(s):	UNIV CHONGQING +
Application number:	CN20191175306 20191106 Global Dossier

The invention discloses a microalgae biomembrane culture method capable of simultaneously improving biomass yield and oil yield. The method is characterized by comprising the following steps of: step1, pre-culturing microalgae: inoculating a culture medium bottle with a trace amount of algae liquid for pre-culturing until microalgae cells grow to a later stage of logarithmic growth; step 2, immobilizing the microalgae cells: immobilizing the pre-cultured microalgae cells to obtain a microalgae biomembrane; step 3, regulating and optimizing a culture medium: adding a certain amount of organiccarbon source into a standard culture medium so as to realize the combination of photosynthetic autotrophy and heterotrophism in a culture process of the microalgae, and regulating and optimizing theratio of inorganic carbon to organic carbon and the ratio of total carbon to total nitrogen in the culture medium so as to realize water circulation and the increase of the biomass yield and oil yieldof the microalgae; step 4, performing inoculation; step 5, performing culturing by combining photosynthetic autotrophy and heterotrophism; and step 6, collecting cells. The method can be widely applied to the fields of energy, biology, especially microalgae industrial culture.

Microalgae sewage treatment device

Page bookmark	CN210214941 (U) - Microalgae sewage treatment device
Inventor(s):	CHEN LI; WANG ZHANLEI; CHEN ZHU +
Applicant(s):	JIANGSU TIANYING ENVIRONMENTAL PROT ENERGY COMPLETE EQUIPMENT CO LTD +
Application number:	CN201920878367U 20190612

The utility model discloses a microalgae sewage treatment device and relates to the field of sewage treatment equipment. The device comprises a membrane separation device and a microalgae treatment device, a sewage inlet of the microalgae treatment device is connected with a sewage source through a fifth control valve; the inlet end of the membrane separation device is connected with the water outlet of the microalgae treatment device; wherein a water production end of the membrane separation device outputs treated sewage, a concentrated water end of the membrane separation device is respectively connected with the first control valve and the second control valve, an outlet end of the first control valve is connected with a sewage inlet of the microalgae treatment device and is used for inputting part of microalgae into the microalgae treatment device in a backflow manner, and an outlet end of the second control valve is used for outputting the rest of microalgae. The device can be suitable for sewage treatment of various scales, microalgae generated after sewage treatment can be turned into wealth, and the device is used for oil production or other applications and has good environmental protection benefits and economic benefits.

System for implementing microalgae-based biomass refining method

Page bookmark	CN210506251 (U) - System for implementing microalgae-based biomass refining method
Inventor(s):	HU GUOQING; LI XIANGHONG +
Applicant(s):	SHOUSHI CITY BORUIDE BIOLOGY TECH CO LTD +
Application number:	CN201821807963U 20181102

The utility model discloses a system for implementing a refining method of microalgae-based biomass, which comprises a pretreatment device, an extraction device and a separation device, the componentseparation device is provided with an algae powder inlet, an algae oil outlet, a protein outlet and a polysaccharide outlet; and the plurality of pyrolysis upgrading devices are respectively providedwith an inlet and a product outlet. Therefore, the system adopts the micro-algae biomass as a raw material source, realizes poly-generation of various oil products such as gasoline, diesel oil and diesel oil on the basis of realizing poly-generation of coke, fuel gas and the oil products, and promotes conversion from the petroleum-based refining industry to the bio-based refining industry. Moreover, according to the system, different raw materials can be blended and selected according to different requirements of gasoline, diesel oil and kerosene in actual production activities, so that the yield of the bio-based liquid fuel is flexibly adjusted, and the economy is greatly improved.

System for trapping and utilizing industrial carbon dioxide by microalgae

Page bookmark	CN212955131 (U) - System for trapping and utilizing industrial carbon dioxide by microalgae
Inventor(s):	SUN YING; ZHOU CHUNYU; HANG XIAOJUN; LIU XUNWEN; ZHANG XIA +
Applicant(s):	NANJING CEC ENVIRONMENTAL PROT CO LTD +
Application number:	CN202021324060U 20200708

The utility model provides a system for trapping and utilizing industrial carbon dioxide by micro-algae. The system comprises an industrial carbon dioxide cooling and flow equalizing system, a culture solution preparation system, a microalgae culture system and a microalgae processing system. Industrial carbon dioxide flows out of the industrial purified tail gas, the temperature of carbon dioxide in the flue gas is reduced through the cooling and flow-equalizing system, meanwhile, the carbon dioxide gas flow is more uniform, the cooled and flow-equalizing flue gas is divided into two parts, one part of carbon dioxide participates in preparation of a microalgae culture solution, and the other part of carbon dioxide participates in photosynthesis required by microalgae growth. And the microalgae periodically grow in the culture system, and the grown microalgae are transported to the processing system to be made into a finished product. Ac-cording to the carbon dioxide trapping device, microalgae with a short growth cycle are fully utilized, carbon dioxide is trapped for photosynthesis to synthesize proteins, polysaccharides, lipids, vitamins, pigments and the like, and high-value additives can be produced while CO2 trapping is realized.

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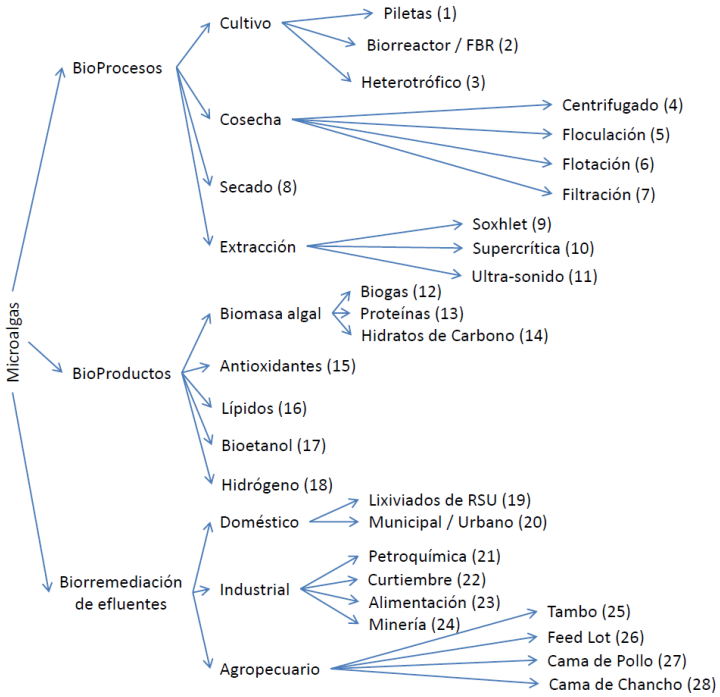

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