A presentation on biobased economy in the EU: a Lab Application research in Taiwan on microalgae culture for biofuels production study

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Abstract

Taiwan is actively pursuing the popularization of sewer system. The conventional and amended activated sludge system is extensively used to deal with sewage treatment or organic wastewater treatment and purification efficiency is quite good but needs to fix sludge further treatments and disposal landfill sites limitation causing raise of costs for the treatment plants and larger carbon foot. Nevertheless, microalgae appear as an excellent alternative for the wastewater treatment. Many studies in the World, including our lab, have proved their powerful ability in the wastewater treatment to remove the nitrogen, phosphor, and organic carbon effectively within few hours and reduce the GreenHouse Gas emission, with production of biomass as the feedstock of biodiesel which production is very much higher in productivity compared to terrestrial plants and brings in on-going interesting studies and projects.

Our laboratory has mastered the key cultivation technologies and know-how in this field, resulting much better growth rate, high lipid content and biomass yield of the microalgae compared to other researches. In this project, our Lab researches are focus on: (1) lipid production of microalgae; (2) artificial wastewater treatment studies by microalgae; (3) the increase of the efficiency of micro-algae treatment study with nutrient substances; (4) microalgae growth rate in mixotrophic culture; (5) reduction of industrial CO_2. In addition to this technology our team will enhance the development and utilization of organic carbon and nitrogen and phosphorus nutrients present in wastewater used as an uptake for microalgae culture, to reduce production costs, as in this method, polluting material will be relieved and digested by algae and transformed into clear water, solving at the same time the cumulating pollution problems of the disposal.

Exploring the renewable energy is becoming one of the most important topics in the near future for sustainable development and microalgae (third generation biofuels) seems to be the most favored bioenergy source for the producers, due their high potential as a direct source of biodiesel supply without competition to food, water resource, land occupation and offering depolluting and decarbonization advantage.

Experiment Design

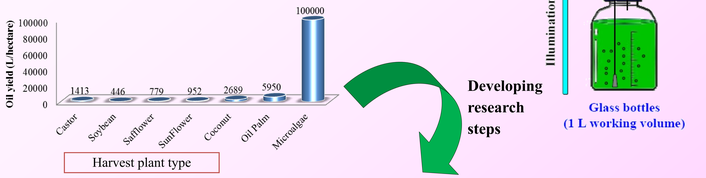
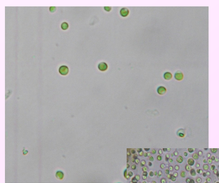
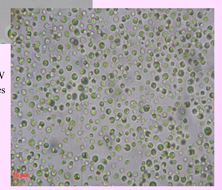


Fig.1 Oil yields based on crop type. (Demirbas et al., 2010)

Developing research steps



Microscopic view of TW species *Chlorella* cultures (start-end)



Biomass production

- Use different cultures methods to understand microalgae metabolic growth characteristics and biomass productions

lipid production

- Experimental reasearches on different culture methods to explore the microalgae metabolic and symbiotic mecchanisms, while increasing the amount of algae growth, lipid content and total lipid amount

Wastewater treatment studies

- Adjustment of best conditions for algae with use of different kinds of artificial and real wastewater to understand and improve the characteristics of microalgae (growth and development, lipid productions...)

Future: environmental and economical assessment and cooperation with industry

- Use Life Cycle Assessment (LCA) method, in-depth evaluation of a variety of microalgae culture methods, in biomass productions and lipid productions
- Hope to cooperate with wastewater treatment plants and related industries

Experiment in Lab-now

(A)

Artificial wastewater

CO_2

Mixotrophic

(B)

Electroplating Wastewater

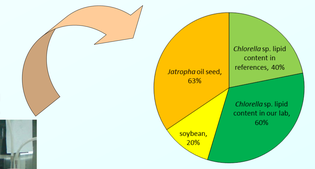


Fig. 2 Comparison *Chlorella* sp., soybean and *Jatropha* oil seed lipid content.

The results of the mixotrophic cultivation when combining the nutrients of carbon-to-nitrogen ratios (C/N = 7) with CO_2 (20%) it comes out that the lipid production and lipid content have the maximum ratio, which are 3.25 and 1.6 (60%) respectively. Furthermore, *Chlorella* sp. cultivated under our lab method has much higher lipid content than other oil plants, such as soybean, which showed in Fig. 2. Also, we manage to obtain super high lipid production and lipid content in mixotrophic cultivation which means 50% more yield production than in separate heterotrophic or autotrophic cultivation.

Fig. 3 showed *Chlorella* sp. biomass yield compared to other oil plants. The results indicated *Chlorella* sp. biomass yield could be very much higher than other oil plants due the yield and capacity of the reproduction of microalgae. When Electroplating wastewater is treated by microalgae in different carbon/nitrogen ratio, the results suggest that carbon/nitrogen ratio 32 obtain the highest lipid content and total concentration for lipids (Table 1). With Semi-continuous culture (C/N 8 and C/N 10), water treatment by microalgae is optimal and the experimental results determined by our Lab method shows best removal efficiency in high concentration of TOC and NO_3^--N(1,600 ppm TOC/day and 200 ppm NO_3^--N/day) (Fig. 4 and Fig. 5).

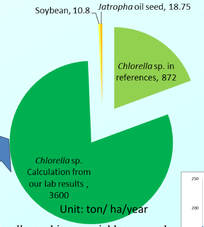


Fig. 3 *Chlorella* sp., biomass yield compared to other oil plants biomass.

Table 1 Experimentation: Effect of C/N ratio on lipid production

C/N	0	6	8	10	12	32
Lipid(g/L)-0hr	0.20	0.20	0.19	0.20	0.20	0.18
Lipid(g/L)-96hr	0.22	0.28	0.29	0.36	0.35	0.57
The increase of lipid (g/L)	0.02	0.08	0.10	0.16	0.15	0.39
Lipid content(%)-0hr	37.2	36.8	35.6	36.9	38.2	37.1
Lipid content(%)-96hr	37.5	37.6	35.3	37.3	39.1	40.3

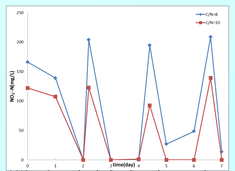


Fig. 4 NO_3^--N/day absorption in Semi-continuous culture

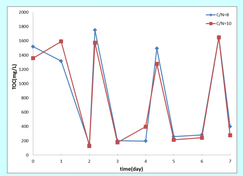


Fig. 5 TOC/day absorption in Semi-continuous culture

A presentation on Biobased Economy applications in the EU

Facing limited resources on Earth and our needs for sustainable development of our economy, the perception in the EU of high technologies role for our future generations has been in alert due the very fast developments of creative scientific researches and innovative systems based on biotechnologies and find viable transition within timely two decades while avoiding interfering with our environment natural equilibrium with Studies and assessments of the involved new industries and sectors of activities productions impact (of processes at genetically and molecular levels, including by-products, size and emissions) on ecosystems. Biotechnologies progress shows very promising with great clean potential to counterbalance Carbon excess and escalation of waste and healthier life and food security. Global warming and researches have been accelerating the process, and create a new sector, called to grow its share in future economy (ahead of their diverse applications and large scales influence on our society). Bioeconomy important sustainable production and Biotechnological conversion of resources issued from our Biomass into a broad range of activities and products (agro-foods, nutraceuticals, health products, industrial chemicals, materials and different forms of renewable energies). Renewable biomass encompasses any biological material (agriculture, forestry and animal-based including fish and microorganisms), a product by itself or, a primary resource in terms of entropy. Potentially, Bioeconomy addresses major environmental issues to maintain a safe, healthy and prosperous environment for current and future generations, (Environmental, climatic, social and economic challenges that are threatening the humanity for irreversibility of situations and lose our unique "home" Earth) the change of the way we live and work for the better if its potential for sustainable production and conversion of biological material is fully exploited. Discussions on sustainability of Biobased researches will be necessary to assess the fragility and complexity of bios stems and their biodiversity, sustain global food security, improve nutrition and health, create smart bio-based products and Biofuels, and help agriculture, forestry, aquaculture and other ecosystems to adapt to climate change, address the grand societal challenges to set out a vision for the long term. EU has set policy recommendations needed to achieve this target. It is the result of a collaborative effort by experts involved in the nine separate Technology Platforms which cover the various aspects of the Bioeconomy and scientific reflections.

Realizing the vision across a range of sectors – arable and livestock farming, forestry, food, aquaculture, the chemical industry, materials manufacturing and energy

This study to evaluate the coherence and integrated policy direction, with key areas being:

• Investment in relevant research areas, both within each of the sectors and by encouraging multidisciplinary programs; • Encouraging innovation to make sure that more of the knowledge developments reach the commercialization stage;

• Making entrepreneurship within the Bioeconomy a desirable career option; • Providing a skilled workforce by making the various sectors of the Bioeconomy attractive career options through secondary and tertiary education;

• A streamlined and innovation-friendly regulatory framework which balances both risks and benefits; Data inventory of Life Cycle based resources indicators • Good two-way communication with the public embedded in R&D projects to ensure societal appreciation of research and innovation.

These sets of policy for specific resources from our biomass are actually, worth to be analyzed. Evaluate the possible control of future research and industrial growth to ensure a real sustainable development, and allow a normalization of newest and highest technologies, for industrial processes and transformation assessing their viability, chain reactions biomaterials and biosubstances and further to the climate change and GHG emissions or balance, to assess possible influence on one hand the environment and natural ecosystems, and on the other hand the sustainability of our economy in a globalised free trade World (ethic, regulations, intellectual property, biodiversity, business models and formation).

The above study is a continuation research to the European overview on biotechnologies, the application research has been made as a viable and high potential third generation energy resource from Microalgae mixotrophic culture and production techniques tentative from waste water, industrial dioxide of carbon for higher efficiency of yield for Biofuels and by-products production conditions.

Conclusion

1) At present, our research team used the Electroplating wastewater on mixotrophic microalgae cultivation and produced an upmost lipid content of 40%, we are expecting to break this limit toward the 60% obtained with Artificial water under photosynthetic efficiency
2) The biomass yield can be 3600 ton/ha/year (calculated from the Lab yield: 4 g/L) which is much higher than other terrestrial crops.
3) Production of bioenergy by microalgae by using waste water with reduction of the sludge disposal and capture of carbon dioxide.
4) TW is experienced for microalgae culture (largest producer of nutraceuticals in the World) and benefit of natural conditions/climate for monitoring open ponds reactors and could be associated to biofuels productions.

Next step

Our team target to complete wastewater treatment process by microalgae, including microalgae culture, harvest, wastewater treatment, and conversion of microalgae lipids into bioenergies.

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