Biorefinery research centre of competence (BIORAF)

BIORAF
Centrum kompetence pro výzkum biorafinací

(O. Šolcová, solcova@icpf.cas.cz; joint project with Institute of Chemistry and Technology, Prague, Institute of Botany of the CAS, Rabbit Trhový Štěpánov, a.s., Agra Group, a.s., Briklis, spol. s r.o., EcoFuel Laboratories, spol. s r.o.; supported by TACR, project No. TE01020080), project web pages (http://bioraf.cz/).

The project established interdisciplinary research centre which resulted in applications in livestock breeding, cultivation and plant protection, food supplements and health care. The companies involved in the project not only supply so far unused waste materials, but already implement and benefit from the project results; new design of bioreactors and knowledge on algae cultivation find use in novel poultry feeding, plant extracts and waxes are tested for cosmetics production and as a repellent for protection of forests, new species of microalgae extremely rich in omega-3 fatty acids are being licensed for production of pharmaceuticals and food supplements, new process equipment are manufactured, *etc*.

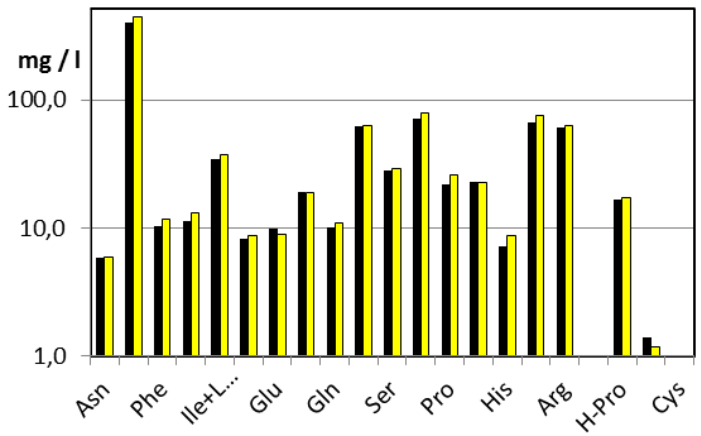
The project brought awareness into society about the biorefinery area as new scientific direction, that in Czech Republic was virtually absent before creation of BIORAF, but has big perspective for development of small and medium size companies.

Pressure hydrolysis of protein in waste of chicken cartilage and feathers in the presence of carbon dioxide

(J. Hanika, O. Šolcová)

Proteins hydrolysis of chicken cartilage and feathers were carried out at increased temperature (till 120 °C) and in the presence of carbon dioxide (partial pressure 10-20 bar), which dissociates in water solution forming an acidic environment supporting the reaction. Carbon dioxide was easily detachable from the reaction mixture at the end of process. Bench scale tests were performed using a mixed autoclave (volume 2.5 L, mixing time 5 h). The resulting aqueous solution of amino acids contained in the same representation as peptides forming collagen and keratin of raw material. The reaction conversion was proportional to carbon dioxide partial pressure.

Pure hydrolysate



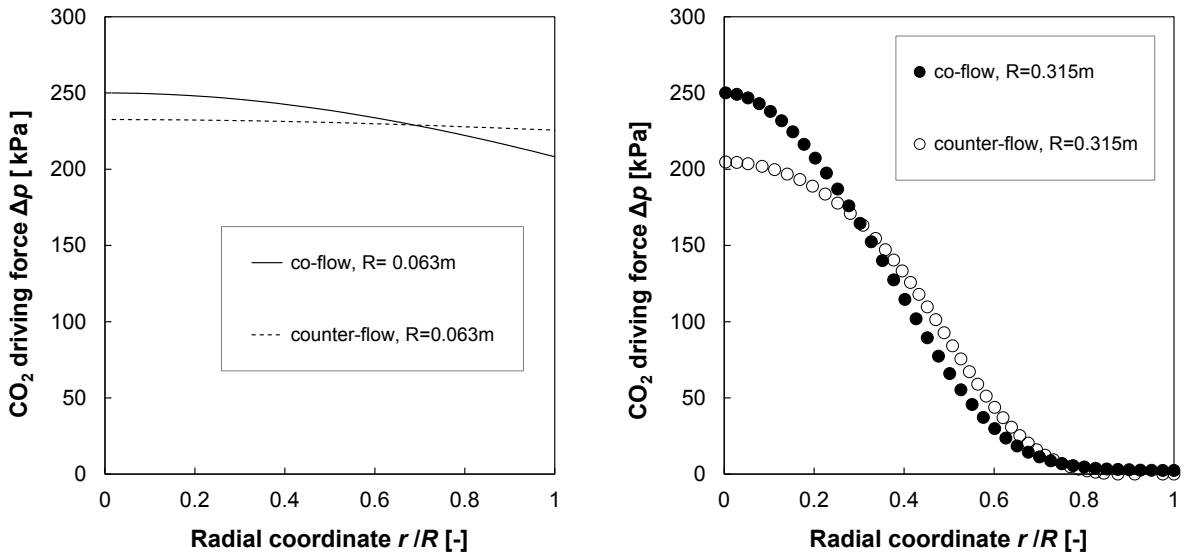
Amino acids distribution in hydrolysate mg/L

The hydrolysis product is perspective one for various applications, first, for dampening the composted agricultural waste, next could be useful as nutritional additives to livestock feed and finally as a nutrient supporting growing algae for biotechnology applications. For any culture, or nutritional usage of hydrolyzate as ingredient in feed mixtures have to be necessary to perform additional relevant field tests.

Membrane separation for biogas purification

(L. Morávková, M. Kárászová, Z. Sedláková, M. Šimčík, J. Vejražka, P. Izák)

Membrane separations were found to be a useful tool for the biogas upgrading. One of the recent break-through in biogas membrane upgrading is application of water-swollen membranes. Its big advantage consists in fact that water present in the raw biogas helps separation and thus, pre-treatment of a feed stream is not necessary such as in the other membrane separation processes. Selection of the suitable membrane material was found to be a complex procedure that includes not only separation properties but also the basic membrane characteristics. To decrease time necessary for the membrane testing before suggestion of a scale-up, determination of the mass transfer coefficients of main compounds contained in raw biogas such are carbon dioxide and methane was suggested. The mass transfer coefficients were evaluated from experiments done on two membranes supplied by Koch and Toray membrane using simple engineering procedure. Further, prediction from the model was compared to the experimental data. The missing data could be predicted using the theoretical mass transfer coefficients. However, it was found that the coupling effect has to be included in the future prediction models to obtain more precise prediction.



Koch membrane. Scale up from R = 0.063 m (experimental cell - lines) to R = 0.315 m (virtual larger cell - marks). Radial profiles of CO_2 mass transfer driving force (the difference of CO_2 partial pressures between both sides of the membrane representing the driving force). Co-flow vs. counter-flow arrangement

Microalgae for bioenergy; key technology nodes

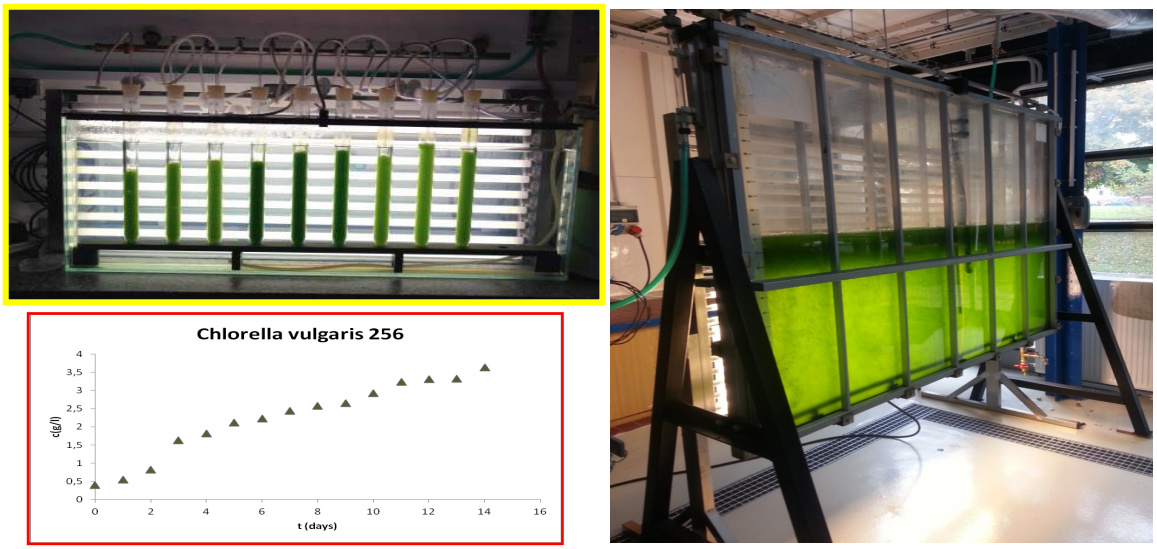
(Y. Maléterová, F. Kaštánek, M. Rousková, M. Matějková, O. Šolcová)

The three key steps, flocculation, water recycling and extraction of microalgal treatment for lipid production have been suggested and evaluated with respect to the possible environmental impacts and production costs. To avoid the energy consuming drying step the completely wet way treatment has been applied. It was verified that ammonium hydroxide can serve as the efficient and the low cost flocculation agent. The optimal flocculation conditions

were determined at pH 9. Moreover the application of ammonium hydroxide brings into the algal water solution only the biogenic elements and thus enables the water recycling for the recurring microalgae growth. Water recycling was verified for the use of 50 and 80 % recycled water.

It was confirmed that extraction of the wet microalgae can be applied instead of the dry microalgal extraction, which enables to release the energy consuming drying step. The efficiency of hexane/ethanol extraction system was found as comparable with chloroform/ methanol system; the comparative method. Moreover, not only the amount of the extraction fraction of the total lipids, but also the profiles of fatty acids was the same. Except of the relatively high extraction capacity, hexane/ethanol extraction system possesses the low volatility and toxicity for humans as well environment and mainly the low cost.

The wet way processing of the harvested microalgae for biodiesel production seems to be the low cost promising biotechnological application with the minimal environmental impact.



Cultivation set-up; growth curve of *Chlorella vulgaris*

Waxes and lipids extraction from miscanthus × giganteus stems

(M. Rouskova, O. Solcova, J. Hanika)

Plantations for experimental production of Miscanthus × giganteus and Miscanthus sinensis have been founded by the project partner AGRA Co. Tall stems of this plant contain a broad spectrum of various substances (waxes, lipids, carotenoids, etc.) being potentially exploitable in cosmetics. Extraction processing of crushed dry stems using non-polar solvent is a promising way for separation of these substances into an extract, whereas the waste raffinate containing waste biomass has, after being pressed into the form of pellets, the potential for energetic utilization as “green fuel”.

Miscanthus sinensis **Miscanthus giganteus**

Publications

Original papers

[1] Hanková L., Holub L., Jeřábek K.: Formation of Porous Polymer Morphology by Microsyneresis During Divinylbenzene Polymerization. *J. Polym. Sci. B-Polym. Phys.* 53(11), 774–781 (2015).

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[3] Klusoň P., Bogdanić G., Wichterle I.: Editorial. *Chem. Biochem. Eng. Q.* 29(1), 1 (2015).

[4] Šolcová O., Šyc M.: Využití odpadů pro cenné produkty a energii. ÚCHP využívá odpady pro cenné produkty a energii. (Czech) Waste Utilization for Valuable Products and Energy. *Vesmír* 94(10), 571 (2015).

[5] Kárászová M., Sedláková Z., Friess K., Izák P.: Effective Permeability of Binary Mixture of Carbon Dioxide and Methane and Pre-Dried Raw Biogas in Supported Ionic Liquid Membranes. *Sep. Purif. Technol.* 153, 14-18 (2015).