

E 5: BIOFUELS AND FUEL ADDITIVES (BFA)

Concerns about the depletion of fossil fuel reserves, the impact of anthropogenic CO₂ emissions, and increasing energy demands have encouraged our research team in exploration of new methods for converting biomass into sustainable platform renewable fuel components.

Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009, on the promotion of the use of energy from renewable sources, aims at achieving by 2020 a 20% share of energy from renewable sources in the EU's final consumption of energy and a 10% share of energy from renewable source in each member state's transport energy consumption.

In this favorable context, the last four years research of Biofuels and fuel additives (BFA) team was focused on biomass processing by production and "upgrading" of chemical entities in order to be used as biofuels and fuel additives, having a strong applicative nature. In the BFA research team composition, average age are 44 years, 50% are members younger than 35 years, 12.5% are PhD, and 37.5% are PhD students.

Component of the BFA team: Stepan Emil – PhD, CS1 (leader team), Dobre Elena - CS1, Radu Adrian CS3, Enascuta Cristina Emanuela – CS, PhD student, Oprescu Elena Emilia - CS, PhD student, Capra Luiza – CS, Faraon Alexandru Victor – ACS, PhD student, Frunza Elena – technician.

Interdisciplinary profile of BFA team allows to carry out applied research in chemistry field and organic chemistry technologies (unpetrochemical products, organic intermediary, complex biomass refinery), unconventional technologies, ecological technologies and products, chemical and instrumental analysis, technological transfer, consulting, management and execution of national and international research projects.

Since 2007, BFA team coordinated 2 RD projects and was involved in other 5 as partner.

In this time increased visibility of BFA team by promotion and better dissemination of results. Members of his team published 9 scientific papers in ISI journals, 13 scientific papers in non-ISI journals, registered 5 patents and 12 patent applications, and presented 19 communications at international symposia / conferences.

Most important achievements:

The last four years, BFA team performed and finalized the following national / international projects:

1. "Complex exploitation of some renewable natural resources to obtain biofuels, glycerine and ecological solvents" - CEEX 2-2005 (BIOTECH), (2005-2008)

Research team was composed of 8 partners (2 of them being small and medium enterprise). ICECHIM was Project coordinator and Stepan Emil - Project manager

Research was directed towards manufacturing 3 classes of products in large quantities, with a strong economic, social and environmental impact, namely: diesel biofuel, ecological solvents, glycerin and towards the investigation of the source of raw materials, the oleaginous plants. The alternative solvents and fuels that will be synthesized and purified will have similar properties with the classic ones, but will be *environment-friendly* products. Purified glycerin falls under the same category of products.

ICECHIM BFA team was developed 2 new technologies, for obtaining 2 new products: diesel biofuel and eco-friendly solvent. Was elaborated 2 patents, was published a paper and 6 scientific communications.

2. "Technologies for green chemistry products, from fat matters" - PN II 31 064-2007, (2007-2010)

Research team was composed of 4 partners (1 of them being small enterprise). ICECHIM was Project coordinator and Stepan Emil - Project manager

Our work was focused on simultaneous production of biodiesel, glycerin, and surfactants (mono- and diglycerides) based on alcoholysis of vegetable oils, using organic base like catalysts. A few catalysts were evaluated concerning their efficiency in obtaining mono- and diglycerides. Different separation techniques were used in the complex system: fatty acid methyl ester / mono- / di- / triglyceride / glycerin.

ICECHIM BFA team was developed 2 new technologies. Was elaborated 1 patent, was published a paper and 3 scientific communications: 2 national communications and 1 international communication (2nd EUCHEMS Chemistry Congress, Turin, Italy)

3. "Biofertilizers and growth stimulators for sustainable culture of plants, with additives obtained by bio-refining of proteic by-products" - CEEX 252-2006, (2006-2008)

ICECHIM was Project partner and Stepan Emil - Project responsible

ICECHIM BFA team elaborated new technologies for biodiesel, biofuel for heating and protein hydrolysed, from leather waste. Were made 2 patents, was published 2 scientific papers and 2 international communications (CESIO - 7th World Surfactants Congress, Paris, France; XXIX Congress of the International Union of Leader Technologists and Chemists Societies (IULTCS), Washington, D.C. USA).

4. “Transesterification of triglycerides in heterogeneous catalysis assisted by unconventional energies: ultrasonic and microwave” - CEEEX 707-2006, (2006-2008)

ICECHIM was Project partner and Stepan Emil - Project responsible

ICECHIM BFA team elaborated new technologies for valorization of crude glycerin obtained as by-product from biodiesel in heterogeneous catalysis production. Research was focused on glycerol derivatization to obtain acetals / ketals, in order to be used as biofuels and fuel additives.

5. “New microorganisms capable of enzymatic synthesis of active therapeutic biopolymers, using glycerin (by-product of biodiesel obtaining)” - PN II 61 006-2007, Stepan Emil – Project responsible (2007-2010)

ICECHIM was Project partner and Stepan Emil - Project responsible

ICECHIM BFA team realized a new technology for purifying of crude glycerin obtained as by-product from biodiesel fabrication, using a variety of raw fat materials and catalysts.

Results were presented as a communication at a national conference.

6. „Biodegradable coolant and lubricating fluid with multiple function” - PN II 32 104-2008, (2008-2011)

ICECHIM was Project partner and Stepan Emil - Project responsible

ICECHIM BFA team developed a new technology for obtaining antioxidant, anti-wear and extreme pressure additives for biolubricants.

Research results were disseminated by 1 patent, a national communication and an international communication (World Tribology Congress 2009, Kyoto, Japan).

7. “Advanced materials obtained by using high tech processing of leather by products”, Bilateral Cooperation Romania – Turkey, between National R&D Institute for Textile & Leather and Ege University Izmir, (2008-2009).

ICECHIM was Project partner and Stepan Emil - Project responsible.

Project was focused on valorization of leather by-products to obtain biofuels, collagen and protein hydrolysed and was finalized for us, as two communications presented at Ist International Leather Engineering Symposium “Leather Industry-Environment and Progressive Technologies”, Izmir, Turkey.

Dynamic research topics and directions

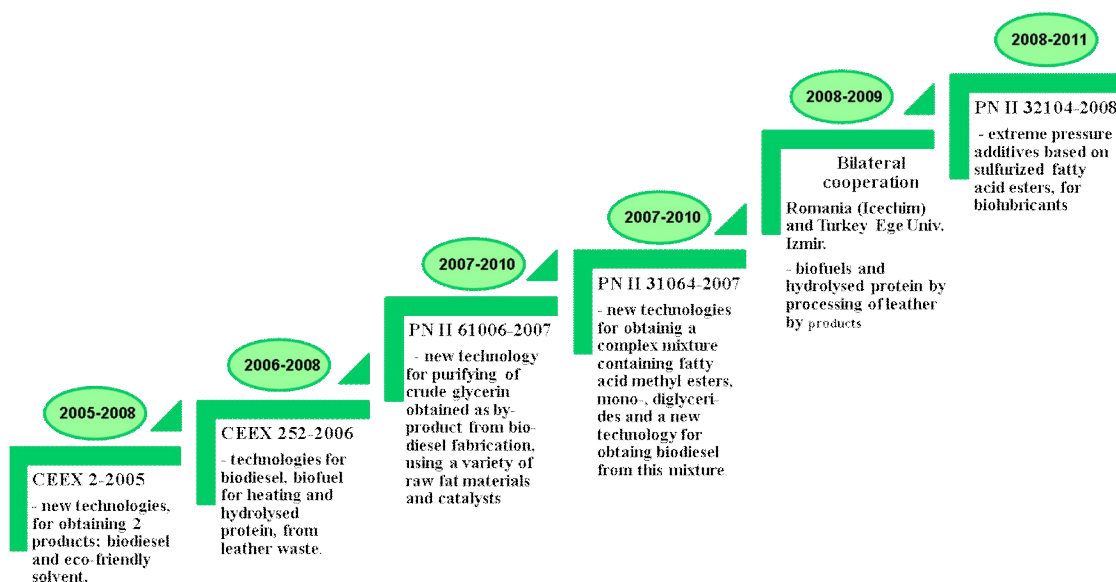


Figure 1. Dynamic of national / international projects

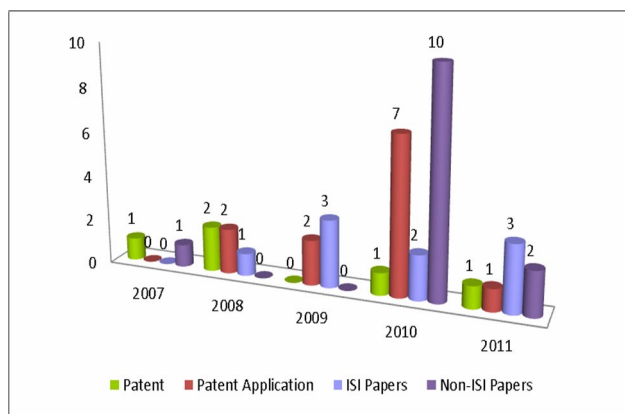


Figure 2. Dynamic of scientific publications

Interdisciplinary and entrepreneurial initiatives

Research team has interdisciplinary profile with members having academic studies and specializations in the field of chemistry, chemical engineering, chemical and instrumental analysis, management of national and international research projects

Human resources evolution

Valuing interests in raw materials from renewable resources began for BFA team in the 90s, being focused on fats processing to obtain biodiesel and anhydrous fatty acid salts.

In the structure of ICECHIM, Bioresources Laboratory was created in 2004, consisting of 2 researchers. Laboratory increased in time by employing new young research assistants. The research assistants were stimulated to promote scientific researcher (3 people) and to attend PhD studies (3 people). In 2008 Bioresources Laboratory was upgraded to Bioresources Department, based on project “Development of Bioresources Department by upgrading the Research & Development infrastructure (BIORES)”, founded by government of Romania by ANCS, CAPACITIES Program. In this department there is “Biofuels and fuel additives” team, composed of 7 scientific researchers; one has PhD degree and three are PhD students.

Other significant aspects for scientific development of the team:

Some patents developed by BFA research team were presented at international exhibitions of inventions being awarded medals:

- **Stepan, E.,** Serban, S., Velea, S., Lata, I., “Diesel biofuel and process for obtaining the same”, *RO Patent 121,913* - EUREKA INNOVA Energy Exhibition, Brussels, November 24th, 2007, **Gold Medal with mention**; INVENTIKA-International Exhibition of Inventions, Scientific Research and New Technologies, Bucharest, October 2-6, 2007, **Gold Medal**
- **Stepan, E.,** Serban, S. Velea, S., “Ecological solvent and process for preparing the same”, *RO Patent 121,859* - 35^e Salon International des Inventions des techniques et produits nouveaux, Geneve 18-22 avril 2007, **Gold Medal** and **IFIA ECO PRIZE, 2007**;
- **Stepan, E.,** Velea, S., Serban, S., “Process for obtaining of diesel biofuel from wastes”, *RO Patent 123,178* - INVENTIKA-International Exhibition of Inventions, Scientific Research and New Technologies, Bucharest, October 7-10, 2008, **Gold Medal** and **Special Prize of OSIM**
- Velea, S., **Stepan, E.,** “Process and photobioreactor for carbon dioxide biofixation, from greenhouse gases” *RO Patent Applications A00288-2009* [INVENTIKA-International Exhibition of Inventions, Scientific Research and New Technologies, Bucharest, October 28-31, 2009, **Gold Medal**
- **Stepan, E.,** Velea S., Tanase, C., Radu, A., Enascuta, C. E., Oprescu E. E., „Process for obtaining a diesel biofuel and tensides from fatty material”, *RO Patent Application 126,669* - INVENTIKA-International Exhibition of Inventions, Scientific Research and New Technologies, Bucharest, October 6-9, 2010, **Gold Medal**
- Gaidau, C., Filipescu, L., **Stepan, E.,** Ghiga, M. D., „Composition of protein additives for nutrition, stimulation, plant protection and process for preparation of it.”, *RO Patent 123,026* - INVENTIKA-International Exhibition of Inventions, Scientific Research and New Technologies, Bucharest, October 5-8, 2011, **Gold Medal, Diploma AROTT,** and **Special Prize of OSIM.**