

## MIRCEN-BITES LJUBLJANA: COOPERATION FOR RESEARCH, EDUCATION AND DEVELOPMENT

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### Summary

The Biotechnological Information Exchange System (BITES) in Ljubljana, Slovenia, was created on the initiative of Dr. Edgar DaSilva in 1989/1990 as an information exchange network of developed and developing countries within the system of UNESCO Microbial Resources Centres (MIRCENs). Its host institution, the International Centre for Chemical Studies (ICCS), became the focal point of research, exchange of knowledge and experiences in integrating research with education and innovation at universities, research institutes and industrial R&D departments worldwide. The following chapter describes examples of ICCS university-industry-agriculture projects in the field of water-retaining polymers for agricultural use, development of a non-toxic pesticide with physical action, based on modified starch dextrines, *Matricaria chamomilla* cultivation project with distillation of essential oils, microencapsulation of animal repellents for prolonged protection of agricultural plants, and research activities in the field of *Ganoderma* medicinal mushrooms. A list of ICCS publications is available on request.

### 1. International Centre for Chemical Studies – ICCS

The International Centre for Chemical Studies (ICCS) was established in 1980 at the University of Ljubljana, Slovenia. Founded and lead by Professor Aleksandra Kornhauser, Director, ICCS became the focal point of an international network of more

than one hundred universities, research institutes and industrial R&D departments worldwide, striving to exchange knowledge and experiences in integrating research with education and innovation.



Figure 1: International Centre for Chemical Studies (ICCS), Ljubljana, Slovenia

The ICCS program includes:

- cooperation in regional and international R&D projects based on chemistry, biochemistry and related disciplines, oriented towards sustainable development and combining fundamental and applied research with developmental projects in industry, agriculture and environmental management,
- organization of seminars and workshops in bilateral and multilateral cooperation, giving special attention to the priorities of UNESCO, and other UN and EU organizations,
- publishing seminar and workshop proceedings, and books integrating contributions in selected areas, disseminating UNESCO publications, and translating some into national languages.

By 2008, the Centre had organized and published the proceedings of over seventy international seminars and expert meetings with close to four thousand participants from over eighty countries.

**ICCS R&D TEAM:**

*Overall Team Leader: Professor Aleksandra Kornhauser*

*Deputy Team Leaders: Professor Bojana Boh, Professor Metka Vrtačnik*

*Members:*

*Marko Ahčan, Janez Benkovič, M.Sc., Bernarda Bregar, Igor Cerar, Andreja Cizerle-Belčič, Danica Dolničar, Professor Saša Glažar, Brina Habijanič, Sonja Jozelj, Dragotin Kardoš, M.Sc., Dušan Krnel, Aleksandra Krumpak M.Sc., Aleš Musar, Ph.D., Radojka Olbina, Ph.D., Iztok Ozimek, Bojan Vnuk, Ivan Vnuk, Nada Vukadinovič.*

## **2. Biotechnological Information Exchange System – BITES**

The Biotechnological Information Exchange System (BITES) was created in 1989/1990 as an information exchange network for developed and developing countries. The starting points for its development were the UNDP/UNESCO Project on Microbial Biotechnology and Bioengineering – Biotechnological Applications, and the UNESCO Microbial Resources Centers – MIRCENS network. The founder and catalysts of the MIRCEN activities was Dr. Edgar DaSilva, Head of the Life Science Division in UNESCO Paris.

The UNESCO International Centre for Chemical Studies – ICCS, directed by Professor Aleksandra Kornhauser, organized the first BITES training course in cooperation with Dr. Edgar DaSilva in Ljubljana from 14 to 18 January 1991, with additional specialized individual training opportunities before and after the course. Twenty-nine participants from nine countries (Albania, Bulgaria, Czechoslovakia, Hungary, Malta, Poland, Romania, Turkey and Yugoslavia) attended the course. The participants came from universities, research institutes, academies of science, governmental research institutions, and industrial research institutes. The program introduced biotechnological information systems and methods, with emphasis on information structuring as support in forming high probability research hypotheses. Participants were introduced to international information systems and online international database processing via international hosts. Every participant received the UNESCO CDS/ISIS program package and was instructed how to design and build specialized in-house bibliographic and textual factual databases on a PC. Building and using relational databases and integrated information systems was presented with explanations of modular and tree structures, related to participant's research problems or needs for information support in educational programmes. Methodology for creating knowledge bases and expert systems was explained by demonstrating examples of rapid responses to water pollution and solving bio-detoxification problems. Computer modelling was examined and discussed as an efficient technique for simulating and optimizing biotechnological processes. BITES European Network and BITES programmes were defined in consultation with all participants. A proposed programme was submitted for approval to the Node-institutions of participating countries. Tasks and follow-up activities for the BITES coordination institution ICCS were agreed upon.

The next year, 29 June to 3 July 1992, ICCS hosted the second meeting of the BITES European network, dedicated to the evaluation and promotion of the results and activities in Central and Eastern Europe, and to prepare project proposals for the next cycle. In spite of the serious problems of the countries in transition, members from 12 countries participated: Albania, Austria, Bosnia and Herzegovina, Croatia, Czech Republic, Germany, Hungary, Macedonia, Poland, Romania, Slovenia and the United Kingdom.

BITES national nodes followed defined national priorities in basic and applied research linked with development. The result of ICCS-BITES activities was a BITES database on biotechnological processes and applications, including close to ten thousand records. Its branches covered general orientation in biotechnological raw materials, processes and products, with specialization on (1) antibiotics for animal use, (2) biotechnological

processes and products based on starch, (3) bioremediation of polluted waters, (4) microencapsulation in biotechnology, and (5) ethanol fermentation. Documents with high relevance to the needs of BITES partners were collected and organized into the BITES primary documentation collection. BITES activities of ICCS in cooperation with industry and agriculture included research on aquaculture, production of bio-chemicals (biodegradable non-toxic pesticides, alcohol fermentation), and bioremediation of polluted waters. Courses on the above topics were organized and studies were made available to the interested BITES partners. At the end of the meeting, a programme “Biotechnology for the environment” was proposed, consisting of five research areas: (1) Microencapsulation for pollution prevention, (2), Animal waste treatment with special emphasis on the waste from large pig farms, (3) Bioremediation of waste waters generated in pharmaceutical and chemical industries, (4) Accident emergency warning system for water pollution response and prevention, and (5) Hazardous materials management information system.

By the end of 1995, ICCS built and offered five specialized databases and information systems within the UNESCO-MIRCENS-BITES network, primarily based on the UNESCO software package CDS/ISIS (Computerized Documentation System/Integrated Scientific Information System):

1. *Antibiotics for veterinary use.* A bibliographic database on antibiotics for animal use was created to support research and development of veterinary drugs in cooperation with the pharmaceutical industry. The main fields of interest were the production and use of selected antibiotics for animal use, including their properties, analytical procedures, isolation and comparison with other drugs. The database included bibliographic data on approximately nine thousand research articles, patents, conference proceedings, dissertations, technical reports and books.
2. *Microencapsulation technologies and applications.* The integrated computer-supported information system on microencapsulation covered scientific and technical information on microencapsulation technology and applications, and consisted of five relationally linked databases: (1) bibliographic database, comprising close to ten thousand documents, mainly patents, (2) factual database on technological processes (interfacial polymerization microencapsulation with cross-linking of proteins in water-in-oil emulsion systems), (3) factual database on synthetic membranes; (4) factual database on chemical recording systems with microencapsulated reactants; (5) factual database on microencapsulated products for agriculture.
3. *Relational information system on mushroom biotechnology (with special emphasis on Ganoderma sp)* with the following modules: (1) pharmacological effects, (2) taxonomy, (3) fermentation processes and technologies, (4) extraction and isolation of pharmacologically active compounds, (5) products and formulations based on the powdered dry mushroom, mushroom extracts, or isolated chemical compounds, (6) chemical compounds - structures and properties.
4. *Integrated multimedia information system on superabsorbents – water retaining polymers*, which consisted of (1) a bibliographic database and factual modules on superabsorbents (2) commercial superabsorbent formulations, (3) published tests with agricultural superabsorbents, (4) chemical structures and other properties of superabsorbents, (5) results of own research and tests, (5) a collection of photo documentation.

5. *An information system on waste management*, consisting of (1) waste management bibliographic database, (2) register of hazardous waste, (3) relational database on river water pollution.
6. The results of BITES have been widely presented and used in many countries, particularly in the countries in transition and in developing countries in Eastern Europe, Africa and Asia (Albania, Belarus, Botswana, Bulgaria, China, Georgia, Hungary, India, Ivory Coast, Japan, Kenya, Kyrgistan, Malaysia, Moldova, Mongolia, Namibia, Poland, Romania, Russian Federation, South Africa, Swaziland, Tunisia, Ukraine, Yugoslavia).

The main goal of BITES has been to support scientists, particularly those in universities in developing countries and in the countries in transition, to recognize their specific opportunities for research, particularly that supporting sustainable human development. Recognition of opportunities for launching knowledge-intensive production processes and environmentally friendly products, and pollution prevention and waste management, have high priority. Selected examples of projects derived from the UNESCO-MIRCEN-BITES program are given below.

### 3. Examples of Projects

#### 3.1. Applications of water-retaining polymers for agricultural use

ICCS, in cooperation with local industry, developed a stable, chemically inert polyacrylic superabsorbent which has the ability of absorbing rain water to the volume of several hundred times its own weight (Figure 2).



Figure 2: Growth of sunflower seedling through hydrated water absorbing polymer  
When mixed with soil, the polymer improves the field capacity, soil structure and air-water regime of the soil (Figure 3).



Figure 3: Addition of water absorbing polymer in a planting pocket

The absorbed water is protected against evaporation and leaching, however, it is available for plant roots (Figure 4). Two forms of water-retaining polymer have been developed: a granular formulation, used as soil or compost additive, and a finely ground formulation, used as a root dip for bare root transplanting.



Figure 4: Seedlings with roots penetrating through the water absorbing polymer

Extensive testing of the water-retaining polymer in pot plants, greenhouses and in open area plantations in semi arid and arid regions has shown the following effects: increased

plant production and crop yields, reduced need for irrigation, alleviated plant moisture stress, more successful plant transplantation, increased seed germination, increased soil aeration with reduced soil compacting and formation of crust, decreased soil erosion, reduced leaching of nutrient substances, usefulness of the polymer retained for several years.

The water-retaining polymer was tested and used in several applications, such as: compost and soil substrates for germinating seeds and transplanting, protection of bare roots during transportation and storage, soil conditioning in arid areas, especially for growing vegetables, reforestation and fruit tree transplanting, pot plants, ornamental plants and grassed areas, eroded surfaces, e.g. construction sites, highway sites, and solid substrates for mushroom cultivation.

Within the UNESCO-MIRCEN program, large-scale experiments have been carried out with the support of ICCS experts by the project partners in Tunisia (Tunisian Institute for Sustainable Development in Tunis), Kenya (University of Nairobi) and in Swaziland (University of Swaziland) (Figures 5 - 7).



Figure 5: Testing superabsorbent water absorption properties (ICCS)

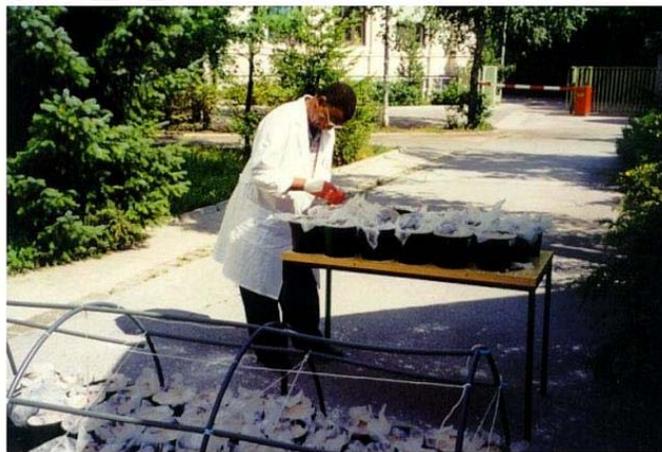


Figure 6: Pot experiments with water absorbing polymer (ICCS)



Figure 7: Testing water absorbing polymer on a pineapple plantation (Swaziland)

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#### Biographical Sketch

**Bojana Boh** - born in March 8, 1960, at Postojna, Slovenia. Dr. Bojana is an associate professor at the University of Ljubljana, Faculty of Natural Sciences and Engineering, Department of Chemical Education and Informatics / International Centre for Chemical Studies.

##### Education:

B. Sc. Biology/Biochemistry, 1983, Biotechnical Faculty, University of Ljubljana, Slovenia

M.Sc. Biochemistry, 1986, Biotechnical Faculty, University of Ljubljana, Slovenia

Ph.D., Chemistry, (Combination of Information and Laboratory Methods in Microencapsulation of Proteins by Interfacial Polymerization), 1991, Faculty of Science and Technology, University of Ljubljana, Slovenia

Post-Doctoral Research, 1993: Institute of Pharmaceutical Technology, Johann-Wolfgang-Goethe University, Frankfurt am Main, Germany.

##### Fields of Work:

(1) Graduate and post-graduate educational programs including scientific and technological informatics, bioinformatics and chemistry of natural products;

(2) Basic research and R&D projects: development of information systems and information methodology with applications in chemistry, biochemistry and biotechnology; research in the field of natural products and their derivatives (*Ganoderma* and *Grifola* polysaccharides, natural dyes, essential oils); development of microencapsulation technologies for applications in agriculture, food, pharmaceutical, paper and textile industries;

(3) International projects: (a) UNESCO programs: MIRCEN-BITES (Microbial Resources Centres -

Biotechnological Information Exchange System); university-industry cooperation; structuring of scientific and technical data for the development of specialized information systems, (b) EU Tempus-Phare project on University-Industry Cooperation - Teaching Strategies; (c) EU COST projects on Bio-microencapsulation; (d) The World Bank projects: Environmental Education programs (1990-93); Scientific Information and Literature (1993); Interactive Educational Technologies (1994); Higher Education and Research (1999-2000), (e) a bilateral project with the University of Nairobi, Kenya, on cultivation of *Matricaria chamomilla* and extraction of essential oils.

*Publications:*

Author or co-author of 8 monographs, 87 scientific articles, 2 patents, 160 reports for the industry, 11 databases; active participation in about 80 scientific meetings

*Accomplishments:*

Pro Natura (Slovenia) / Boehringer Ingelheim Fond (Germany) award for young researchers, 1992.