

Portugal

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1.9. PORTUGAL

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In Portugal, biotechnology has become integrated into the traditional biology dependent industries. Microbiology and enzymology are now finding new applications. Many scientists have returned from training and employment overseas. This new resource of largely European trained scientists is now helping to create new poles of academic and industrial excellence.

The promise of biotechnology is being hindered in Portugal by the lack of entrepreneurial tradition. Human potential and favourable political conditions do not alone create new industries and economic development.

The government is sympathetic and started the implementation of a Mobilisation Programme in 1987. Funding levels for biotechnology have increased each year and are being complemented by funds from the European Commission and with A.I.D.

This presentation attempts to identify the impact of biotechnology on Portuguese industry and agriculture as well as its potential in research and education.

INDUSTRY

The industries involving biotechnology can be divided into two sectors, one more traditional and the other of a more modern kind which can be situated in the post antibiotic era.

In the first case, it is justifiable to start by referring to the wine industry, which has acquired great importance both internally and for export income. Port, Madeira and some Rosé wines contribute most.

The fruits of yeast research are now being enjoyed. Strain selection and slow fermentation conditions are being optimised so as to minimise undesirable contamination or side products. The sparkling wine industry is exploring the possibilities offered by immobilised yeast cells and continuous fermentation.

In the cheese industry microbial enzymes are used in large scale production, but the best cheeses, called Serra, are still produced traditionally. Cardoon flowers are immersed in sheeps milk, a process prone to contamination and quality variation. Family production methods are being studied in the laboratory so as to identify proteases. It is hoped that it may be possible to produce cheese '*in vitro*' with suspended and immobilised cardoon cells.

The old olive oil industry could be improved with better extraction processes and regeneration of the older plantations. New technologies such as micropropagation could play a useful role.

The beer industry has achieved a sophisticated understanding and control of the processes of malting and fermentation.

Antibiotic production is a significant export earner, with more than 90% exported. The major products include: penicillin, tetracycline, oxytetracycline, erythromycin, gentamycin and ampicillin.

A new ampicillin process was developed in Portugal, whereby 6-aminopenicillinic acid was formed by passing penicillin through novel bioreactors containing immobilised penicillin acylase. The technology has been successfully exported.

The fine chemicals industry carries out R&D, often in collaboration with university laboratories. Products have included steroids and some diagnostic kits.

Baker's yeast is produced at two locations, while glucose and glucose/fructose syrups are obtained with enzymatic processes.

Alcohol factories depend upon imported molasses (some 15% produced domestically). This traditional industry is now moving towards an incorporation of the new biotechnologies.

Environmental considerations have not been overlooked. Several wastewater treatment plants have been constructed using a variety of technologies: activated sludge, percolating filters and a variety of ponds. Several cattle and poultry raising installations have built tanks for anaerobic digestion, using the resultant biogas for ambient heating or electrical energy production.

AGRICULTURE

Portuguese agriculture is a very traditional discipline and the only biotechnological input has been from classical genetics. In the future biotechnology will affect agriculture in two ways. Firstly, the fruits of research will influence the growth and multiplication of plants, possibly by species improvement by gene transfer and classical hybridisation etc. The sum of many developments in Nitrogen fixation, *in vitro* propagation and so on might radically modify the culture of a given region. Already some hybrid cereals have dramatically improved the productivity of some regions. *In vitro* propagation has so far been applied only to high value decorative plants and exotic fruits. Many technologies are unexploited, for example the knowledge of coffee developed in former colonies.

The second major influence may come about when agriculture is in a position to provide industrial raw materials. The introduction of new cultures or the modification of old ones may bring about changes. At the moment trials are underway with an inulin producing Jerusalem artichoke. Suitable for fructose, or by fermentation, alcohol production this could become both a food and energy source.

Native biological resources are not overlooked. Plants of the semi arid interior might be used to produce commercial quantities of lipids from marginal lands. Euphorbia is presently being studied as a candidate for exploitation.

RESEARCH

In recent years there has been an important increase in biotechnology research. Little has yet emerged from this new development. In traditional areas such as yeast physiology and fermentation, Portuguese scientists have established a high standard of excellence. Fields of application would include yield improvement and alternative methods of fermentation product extraction, so as to reduce the energy costs of distillation.

Immobilised enzymes and micro-organisms are quite routine applications in the fields of antibiotic production and sparkling wine manufacture.

Plant cell culture has yielded important developments in the areas of callus production, micropropagation and suspended cell culture. Other applications are in development.

In the area of environmental biotechnology a town of 13.000 population is successfully demonstrating the use of high photosynthetic rate ponds for sewage treatment.

At least three of the nation's research centres have been looking at the technologies of fermentation and down stream processing. Purification and separation of fermentation products using ultrafiltration membranes, and supercritical extraction of natural products exemplify this interest.

The bio-conversion of energy is being studied by groups whose focus is on energy mediating enzymes such as the hydrogenases. *In vitro* reconstitution of such activity could yield commercial benefits.

Other small groups are looking at genetic engineering, immunology, virology, monoclonal antibodies, etc.

Most research is carried out in university laboratories and public and private institutes. Industrial concerns only rarely have established an R&D competence, relying instead on outside agencies. This must change if industry is to face a sound future.

An Institute of Chemical and Biological Technologies is being commissioned with the purpose of establishing links between biotechnology, agriculture and the agro-food industries.

EDUCATION

Several new courses have been inaugurated to train graduates in the skills required by tomorrow's institutional and industrial needs. The New University of Lisbon launched an Applied Chemistry course with a strong biotechnology component. In the Technical University of Lisbon, the Instituto Superior Técnico, a biotechnology course is taught during the five year Chemical Engineering degree. In Oporto a food engineering course was started four years ago within a Faculty of Biotechnology.

At postgraduate level two courses exist, at the New University of Lisbon, in conjunction with the Gulbenkian foundation and at the Instituto Superior Técnico.

LINKS WITH LATIN AMERICA

Portugal has a long standing tradition of openness to the outside world, a consequence of the past colonial tradition and associated migrations.

Brazil and Portugal have particularly close ties, resulting from a common history over several centuries and a common language. At present high level talks are aimed specifically at creating a collaborative relationship in the field of biotechnology. Joint workshops have been held, with a view to establishing common programmes.

One type of link that may develop between Portugal and Latin America involves technology transfer from biotechnology using industries. A new antibiotics factory in Brazil, CIBRAN was designed in Portugal and at least initially was dependent upon Portuguese technology.

Portugal's interest in fermentation and downstream processing, alcohol and biocatalysis may be of particular interest. Support for developing these technologies has come from the European Commission.

Tropical agriculture, pest control and disease are points of common interest and expertise with a potential for fruitful co-operation.

Educational links are particularly favoured with Brazil. Portuguese universities receive many Brazilian students onto their M.Sc. courses and are willing to accept Spanish or Portuguese speakers onto Ph.D. degrees. Both Latin American and Portuguese workers have shown the willingness to travel so as to learn or teach new technology.

The mobility of research workers and teachers seems of fundamental importance if Portugal and Latin America are to keep pace with modern developments. It is essential to create bridges between Europe and Latin America. The funding of a programme to this end would be of great value.

Annex: List of Organisations Active in Biotechnology in Portugal

Industry	Cipan
Antibiotics	Soc. Port. Leveduras Seleccionadas
Fine Chemicals:	Quatrum Hovione France-Farmaceutica
Baker's Yeast:	Propam Soc. Port. Leveduras Seleccionadas
Starch:	Copam
Breweries:	Centralcer Unicer
Plant Micropropagation	<i>In Vitro</i> Plants
Research	
Yeasts:	Instituto Gulbenkian de Ciencia, IGC Universidade do Minho
Alcohol Fermentation:	Instituto Superior Técnico, IST Faculdade de Engenharia da Universidade do Porto Laboratório Nacional de Engenharia e Tecnologia Industrial, LNETI
Environmental Biotechnology:	Universidade Nova de Lisboa, UNL IST Universidade de Aveiro LNETI
Immobilised Biotacalysts:	IST Universidade de Coimbra
Algal Biotechnology:	Instituto Nacional de Investigação das Pescas, INIP LNETI IST
Energy from Biomass:	LNETI
Bioreactor design and Downstream Processing:	FEUP IST UNL
Hydrogen and Methane Production:	UNL
Genetic Engineering	IGC Instituto de Ciencias Biomedicas, ICBAS
Plant Cell Biotechnology	Faculdade de Ciencias Lisboa, FCL Estação Agronômica Nacional, EAN
Tropical Plants:	Centro de Investigações do Café EAN

Plant Genetics:	EAN Estação de Melhoramento de Plantas de Elvas IGC Universidade de Tras-Os-Montes e Alto Douro
Fine Chemicals, Diagnostic kits:	LNETI IST
Food Biotechnology:	LNETI Escola Superior de Biotechnologia, Porto Instituto Superior de Agronomia
Wine Research:	ISA Estação Vitivinícola Nacional
Aqualculture:	ICBAS INIP
Monoclonal Antibodies:	IGC ICBAS
Lignocellulose degradation:	ISA LNETI
Biogas Production:	LNETI UNL
Virology:	IGC
Human Biotechnology:	Instituto Nacional de Saúde Pública
Animal Biotechnology:	Escola Superior de Medicina Veterinária Laboratório Nacional de Investigação Veterinária
Immunology:	Universidade de Coimbra

Further information on Portuguese biotechnology centres can be obtained from the speaker or from the following institutions:

JNICT – Junta Nacional de Investigação Científica e Tecnológica, Av. D, Carlos I, 126-1o, 1200 LISBOA, PORTUGAL

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