

S Almomin and N Al-Awadhi

Biotechnology in Kuwait: A Review of Progress and Prospects

Abstract: Biotechnology has received significant recognition in Kuwait as the science of the future. The scientific research in this field is shaped by the need to solve national problems mostly in areas of health, environment and food security. The annual expenditure on biotechnological research is in excess of US \$5 million among the research institutions in the country.

The objective of this review is to present the current scientific achievements and progress in biotechnology in the State of Kuwait.

التكنولوجيا الحيوية في الكويت

المستخلص: تعتبر التكنولوجيا الحيوية من أهم العلوم المستقبلية التي حصلت على اهتمام خاص ومميز في الكويت. يتبع البحث العلمي في هذا المجال ويتشكل وفقاً للحاجة لمعالجة المشاكل المحلية الخاصة بالصحة والبيئة والأمن الغذائي. هذا ويبلغ الإنفاق السنوي في مختلف المراكز العلمية في الدولة على هذه البحوث ما يقارب الخمسة ملايين دولار أمريكي.

تهدف هذه الدراسة إلى استعراض الوضع الحالي لأهم التطورات والإنجازات التي تمت في مجال التكنولوجيا الحيوية في دولة الكويت.

Introduction

Biotechnology is one of the oldest sciences in human civilization, starting with fermentation techniques and cheese production. However, in spite of this fact, it has only been boosted in the 1970s with the advent of genetic engineering techniques. Both sciences are concerned with the use of living organisms for commercial applications that have certain economical/social aspects which in turn shape and direct the science itself. Biotechnology in the developing countries is still at an experimental stage. It has been growing slowly and making few breakthroughs.

Kuwait is one of the leading countries among the developing world that has put a serious effort in developing and applying biotechnical techniques in solving its national problems.

In general, scientific research, and in particular, research in biotechnology and related sciences of genetic engineering, is conducted mainly within two institutions, Kuwait Institute for Scientific Research

(KISR) and Kuwait University (KU).

The funding for research in both institutions is primarily dependent on the state government and to a lesser extent on contract research with national agencies and ministries such as the Kuwait Foundation for the Advancement of Science (KFAS), the Environmental Protection Council (EPC), and the Public Authority for Agriculture and Fisheries (PAAF). Contributions of the private sector to conduct or support biotechnology and research development are negligible.

National Committee on Genetic Engineering and Biotechnology

The Government of the State of Kuwait has recognized the potential long-term benefits of biotechnology, and has formed a National Committee on Genetic Engineering and Biotechnology in consultation with UNIDO in 1989. The Committee is to act as a National Safety Committee and has set up a National Plan for the development of Biotechnology and Genetic Engineering in Kuwait. Kuwait also is a member of the International Centre for Genetic Engineering and Biotechnology (ICGEB). In this regard, the Committee has identified six research areas as priority fields of research:

S Almomin and N Al-Awadhi
Kuwait Institute of Scientific Research,
P.O. Box 24885, Safat 13109
Kuwait
Tel: (965) 2425898
Fax: (965) 48346670

- Use of DNA-based genetic diagnostics related to clinical genetics and health.
- Production of biomass and fine chemicals from methanol and petroleum by-products.
- Use of micro-organisms for biosurfactant production and pollution control.
- Marine genetic engineering and biotechnology.
- Agricultural plant tissue culture and crop improvements.
- Production of industrial enzymes.

Work in some of the above areas has not been initiated due to the discontinuation of the Committee since the Iraqi aggression in Kuwait in 1990. This event changed the priorities in the research areas as new problems have evolved due to the postwar reconstruction, such as food security and environmental safety, which became the major concerns of the country. Increased food self-sufficiency became the main objective of the biotechnology programmes and the problem is to be tackled through the use of biotechnology and genetic engineering to modify and increase production in plant and animal agriculture, fisheries and aquaculture. In addition, the invasion resulted in the destruction of oil production facilities where vast amounts of crude oil were released into the environment. This has caused marine, terrestrial and atmospheric pollution. As a result these newly emerged areas have reoriented the research direction and priorities.

The Kuwait Institute for Scientific Research (KISR)

KISR was established in 1967 to support national industries by conducting scientific research in problem areas. It is the only scientific institution in Kuwait which has a defined biotechnology programme and a five year national strategic plan (KISR, 1995-2000). The programme identifies local problems that can be solved through using biotechniques and offers potential economic benefits.

A special department for Biotechnology was established in 1980. The first major biotechnology project was on the production of single cell protein as animal feed. This was followed by a related project on the conversion of cellulosic products to be used for animal feed. The total investment for

these projects amounted to US \$4.3 million, including the establishment of a pilot plant facility of 1500 litres fermentor capacity.

Priority areas include genetic engineering, cell and plant tissue culture, food technology, bioremediation and fermentation, with emphasis on agriculture, animal health and environmental safety. The current investment in the projects underway in biotechnology is approximately US \$4 million with almost 50% of client funds. Current and ongoing projects in the research biotechnology program includes:

- Improvement of plants for stress tolerance and insect resistance through identifying the genes concerned.
- Bioremediation and rehabilitation of oil-contaminated soils.
- Development of molecular probes for disease diagnosis in livestock.
- Increased production of plants through tissue culture techniques.
- Food quality control and detection of contaminants.
- Establishment of techniques to ensure trueness-to-type of the date palm.
- Application of embryo transfer techniques for sheep production improvement.
- Development of DNA fingerprinting techniques for marine species.
- Carrying out field tests and development of an action plan for remediation of oil-contaminated soils.
- Development of microbial-based products, e.g. biosurfactants and bioinsecticides.

The Biotechnology Department has achieved significant accomplishments in several areas. Currently, a pilot scale commercial delivery system of true-to-type plantlets of date palm and native plants through tissue culture is in operation. Similar advanced stages of project development have been reached with the bioremediation of oil-contaminated soils. Embryo transfer in sheep is a new advanced technique that has been introduced to study its feasibility to increase local sheep production and possibly establish the basic techniques for possible future studies on transgenic animals.

Kuwait University (KU)

Kuwait University is the only University in Kuwait, and has around 553 multidisciplinary research projects. There are 193 projects in the Faculty of Science and Faculty of Medicine, out of which 18 are in the area of biotechnology and molecular biology. This represents 9.3% of the scientific research in the faculties and 3.25% of the total research in the university. The university funded 92.4% of the research, while for the rest the major support was received from KFAS.

The research at KU is initiated and directed on an academic basis rather than on a defined plan or strategy of the institution.

According to the 1995 Kuwait University Research Abstracts Publication (Kuwait University, 1995), 18 new scientific areas have been added to the already existing fields of research and studies, one of which is molecular biology. This indicates the importance of the newly emerging areas of research.

The current main research areas in molecular biology and biotechnology in Kuwait University are categorized into two main areas (Kuwait University, 1999). One area is Environmental Biotechnology, where the emphasis is on oil and hydrocarbon degradation and bioremediation. Research is mainly focused on the following:

- Oil-degrading rhizospheric microorganisms as potential contributors to the self-cleaning bioremediation of Kuwait desert.
- Hydrocarbon degradation by naturally immobilized micro-organisms along the Kuwait coasts.

The second area that is mostly dominated by using genetic engineering techniques is medical biotechnology, mainly the detection and typing of infectious pathogens such as:

- A study of the level of antibiotic resistance and molecular epidemiological typing of clinical isolates of *Salmonella* type.
- Selective inhibition of cyclooxygenase 2 by antisense gene therapy in experimental *colitis*.
- Detection of *P. talciparum* in clinical samples by PCR.
- Cloning and expression of *mycobacterium tuberculosis* specific genes and immunological evaluation of recombinant proteins and synthetic peptides.

- Isolation and characterization of cell cycle genes from *Candida Albicans*.
- The prevalence of human T1-lymphotropic virus infections in Kuwait and the comparative molecular characterization of regional strains of these agents.

The total funding of the projects is approximately US\$ 1.2 million.

The Kuwait Foundation for the Advancement of Science (KFAS) contribution is US\$ 284,760, which is equal to approximately 23.7%.

The Public Authority for Applied Education and Training (PAAET)

The PAAET has been established in 1982 to meet the growing needs for technical and applied education in Kuwait. The main objective of the Authority is to develop a national labour force to meet the national needs for skilled manpower through education and training.

Recently PAAET proposed the establishment of a Centre for Environmental Deterioration Studies. Biotechnology was recognized as an area of importance among the research elements that the Centre aims for and its techniques are to be applied in environmental studies. However, there are no defined research projects so far as the Centre is still in the developing stage.

Kuwait Foundation for the Advancement of Science (KFAS)

The State of Kuwait has established KFAS as a result of an Amiri Decree in 1976. This establishment is in collaboration with the private sector, which is considered one of the unique examples among the developing countries, specially where the private sector contributes 2% of its profit. It is also viewed as a scientific base for promoting quality research in the country. The Foundation's main objective is to extend timely and broad scientific support, by implementing a variety of scientific programmes through grant-awards, in order to provide Kuwaiti scientists with the opportunity to conduct hands-on technological research, whilst simultaneously training aspiring young Kuwaitis. KFAS, in 1999, has awarded grants to 28 new projects with a budget of \$ 1,634,043, in addition to 51 ongoing projects. The main emphasis and priorities are given to research in areas of water, oil, health and environment. Only six of the projects are in biotechnology and related areas. Medical and life sciences funds in research projects 1997-1999

were \$ 2,907,647. Biotechnology projects funds according to a KFAS report in 1999 were \$ 431,910, which comprise approximately 15% of the total budget for scientific research excluding Engineering Sciences. The funded biochemical and genetic engineering projects are the following:

- DNA fingerprinting for population identification of shrimp
- Development of specific DNA probes for *Brucella*
- Propagation of native desert plants by tissue culture techniques
- Identification of antigens of Mycobacteria for specific diagnosis and vaccine development
- Establishment of molecular methods for the detection of emerging bacterial pathogens in Kuwait
- Clinical and molecular genetic analysis of spinal muscular atrophy.

The main beneficiaries of the grants awarded are KISR and KU. The annual expenditure on scientific research in Kuwait is 0.7% of the national income with 0.75 researcher for every 1000 employees. This expenditure might look modest on the international level, but is considered one of the highest in the Arab world. This indicates that Kuwait commonly shares limitations in scientific research as the rest of the developing countries. The limitations can be identified as :

- The lack of clear policies and planning of research.
- Shortage of trained human resources.
- Lack of competition between agencies and industries which leads to the isolation of the research role in the national development.
- Increased dependency on foreign consultancies.
- Most of the research budget is spent on overhead cost and a small portion, < 1% of the national income, on research activities.
- Limitations of access to national data.
- Lack of awareness of the role and benefits of biotechnology in society and science.
- Limitation and delays in importing necessary equipment and reagents.

Future Prospects

Kuwait has turned to its biological resources in recognition of the need for their conservation and development, an attitude that has come as result of the environmental catastrophe following the Iraqi invasion. In Kuwait, the annual expenditure on scientific research is 0.7% of the national income with 0.75 researcher for every 1000 employees. In the Arab world such expenditure is considered one of the highest (KFAS 1995).

The signing of the Convention on Biological Diversity in Rio de Janeiro in 1992 emphasized the value of biotechnology as a tool to execute such a commitment. The state government at present is setting out related national committees, formulating legislation and plans of action, a policy hitherto lacking but critically needed.

Regionally, the State of Kuwait is considered to be a leading country in biotechnology and has recognized that it has an important role to play in economic and industrial development. The identification of national problems such as improvement of natural resources, environment, food and health, has put a great demand on the utilization of biotechnology to solve such issues. There is a critical need for a well-defined long-term scientific policy and legislation. A plan of action is also needed to put more emphasis on manpower training through academic education, public awareness and international collaboration. There is no doubt that Kuwait, although having an experience of just 20 years in the sector, nonetheless has a good opportunity in the future to be well placed in the international biotechnology arena.

Acknowledgement

The authors acknowledge and express their thanks to the Kuwait Foundation for the Advancement of Science (KFAS), The Kuwait University and The Kuwait Institute for Scientific Research (KISR) for their contribution to the data and information.

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(Received 26/11/2000 In revised form 20/12/2000)