Summer 2000
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MEETING THE NEEDS OF A GROWING POPULATION

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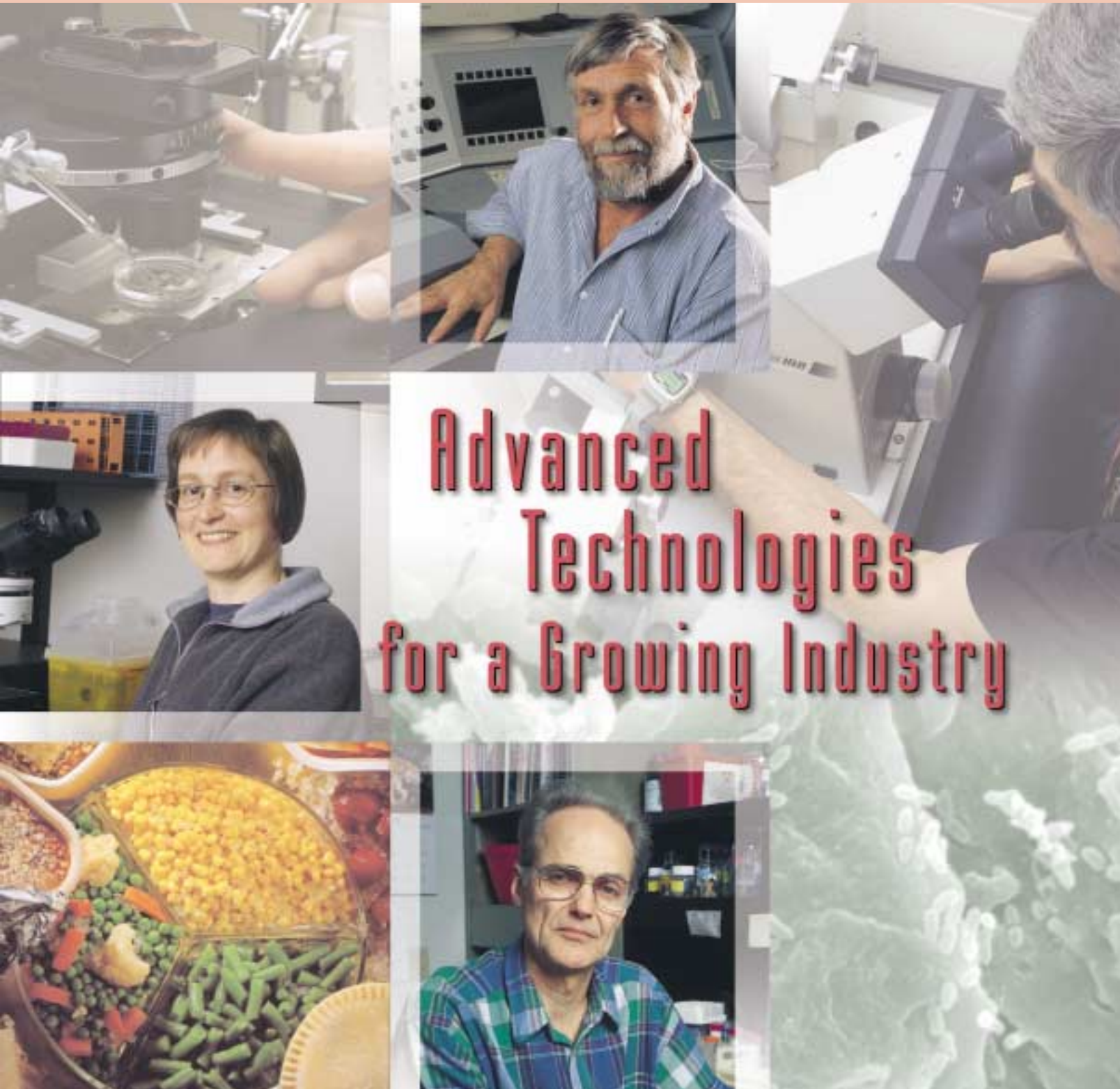
TRANSGENIC PLANTS

SUMMER 2000 VOL.24 NO.1

Ontario
Ministry of Agriculture, Food and Rural Affairs
Ministère de l'Agriculture, de l'Alimentation et des Affaires rurales

Agri-food research IN ONTARIO

La recherche agro-alimentaire EN ONTARIO



Advanced Technologies for a Growing Industry

Ontario Ministry of Agriculture, Food and Rural Affairs
1 Stone Road West
Guelph, Ontario
Canada
N1G 4Y2

ISSN 1192-7704

Ontario

This magazine is printed on recycled paper using vegetable based ink.

Min Seok Chae, a graduate student in the Department of Food Science, University of Guelph, uses an automated system (Spiral Plates) to count bacteria grown in a biofilm.

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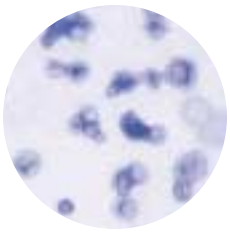
Formerly *Highlights of agricultural and food research in Ontario*



MEETING THE FOOD NEEDS OF A GROWING POPULATION

TRANSGENIC PLANTS

Editor:
Alison Lane

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David Barr

Cover: University of Guelph researchers, clockwise from top, Terry Beveridge, Cecil Forsberg, and Heidi Schraft.
Back cover: Min Seok Chae, graduate student.

Check out recent issues at our website: **www.gov.on.ca/omafra/english/research/index.html**

ON THE HEALTH FRONT

FOOD SAFETY

CONSUMER INFORMATION

About the authors

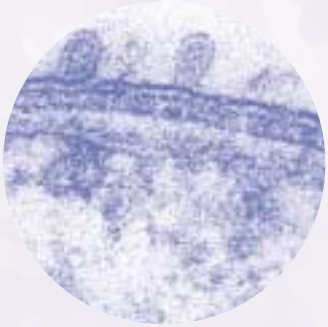
Articles pertaining to research at the University of Guelph were prepared by students in the SPARK – Students Promoting Awareness of Research Knowledge – program and by participants in the Fall 1999 Agricultural Communications class, both at Guelph.

The Forefront was penned by Robyn Meerveld.

Other articles pertaining to private-sector research were prepared by Alison Lane with the assistance of staff from each of the featured companies.

Information on research

For more information on research at the University of Guelph, or to contact one of the researchers, visit **www.uoguelph.ca** or call **(519) 824-4120**.



Toronto is the site of this year's Agricultural Biotechnology International Conference, one of the world's première gatherings of life sciences researchers and business. The conference runs from June 5 to 8 at the Sheraton Centre Downtown.

International delegates at more than 50 sessions and dozens of world-renowned speakers will be challenged and informed on the critical issues of the day: intellectual property protection, biotech's global business and consumer trends, and the latest innovations in crop and livestock production and value-added processing.

In Ontario, food safety and quality are paramount in new production and processing technologies. So you can expect biotechnology's role in improved food safety diagnostics, extended shelf life, reduced pesticide use, and enhanced nutritional qualities to be front and centre.

New industrial uses for genetically modified crops are also emerging on the horizon of 'greener' products. Less polluting fuels, non-hydrocarbon polymers, reduced waste streams, environmental remediation, and pharmaceuticals produced more efficiently in plants and animals, all point to the growing convergence of life sciences industries.

We hope you share in the excitement of ABIC 2000 and enjoy your stay. Take advantage of the tours to view some of the best research facilities in the world, and read about the growing success stories of Ontario's agri-food biotechnology sector.

ONTARIO
CANADA
THE FUTURE'S RIGHT HERE

JENNY TYE

Food for the Future

Efficient food production is the priority at new biotech research centre

Moving biotechnology research from concepts to outcomes is the motive behind the University of Guelph's new Food Systems Biotechnology Centre (FSBC), a research initiative at the forefront of agricultural and food production.

As Canada's population grows, so does the need for efficient food production that minimizes its impact on land and resources. That's why farms — many of which are multi-million-dollar operations — have started turning to biotechnology for options. With the future in mind, the FSBC was created to develop new value-added animal and crop products and related food systems that will help meet producers' technology needs and the country's land resource requirements.

The goal for the Centre, an amalgamation of three research sectors at Guelph, is to use biotechnology to secure and expand Canada's food production industry. Interest is high within the University and among agricultural producers with whom the University has worked for decades. Prof. Alan Wildeman is the FSBC's director.

Under the umbrella of the FSBC, researchers will incorporate recent advances in the field of molecular genetic technology as well as traditional genetics research to develop improved crop and horticultural plant varieties, improved animal production systems through cloning and transgenics, and state-of-the-art molecular technologies.

According to Prof. Larry Milligan, Vice-President (Research), capturing the enormous economic potential of biotechnology in these fields will help ensure the prosperity of Ontario and Canada in the 21st century. These areas are increasingly important for the development of value-added products, which will further the long-term global competitiveness and sustainability of Ontario's agri-food industry.

The Centre is supported equally by three funding sources, for a total of $18.6 million. The Ontario Research and Development Challenge Fund (ORDCF) and the private sector are each providing $6.2 million; the remaining support will be provided by faculty research grants and other commitments from the University.

The FSBC is in part a means of supporting researchers in their efforts towards forming private-sector relationships in this area. According to Wildeman, when researchers spend time fostering private-sector linkages, it has a ripple effect throughout the campus. Private-sector research support acts as a major lever for government sources of funding, and by having a centre that is organized from within Guelph, the research being done is visible to the full academic community.

In addition to the ORDCF funding, the Canada Foundation for Innovation (CFI) is providing another $3 million in infrastructure support for the three sectors within the FSBC. This funding represents 40 per cent of infrastructure costs, primarily for the acquisition of technology and equipment. The CFI support is being matched by the province, and the remaining required funds are coming from the University and private-sector sources. The total value of these infrastructure awards is $7.5 million.

The three research sectors of the FSBC — plant, animal and molecular genetics — have separate but linked roles to play in fulfilling the Centre's goals. One example of the enormous potential is a high-profile transgenics project: the EnviroPig developed by Prof. Cecil Forsberg, Microbiology, and Prof. John Phillips, Molecular Biology and Genetics (see story on pg. 6). The animal excretes significantly less phosphorus than normal pigs do and could prove to be an environmental boon.

The FSBC will also be involved in transgenic plant research. For example, Prof. Larry Erickson of Plant Agriculture is working to produce alfalfa containing antigens that confer immunity to viral diseases in livestock. And in the molecular area, FSBC researchers are developing important tools such as DNA chips, molecular devices important in plant and animal biotechnology, and new and improved techniques for DNA and protein analysis. The molecular sector of FSBC will work closely with Laboratory Services to help move new technologies to commercialization and develop molecular tools for assessing food safety.

Wildeman says knowledge gained through research benefits graduate students and has a big impact in undergraduate classrooms. The enthusiasm of researchers is passed on to students, and the FSBC will provide opportunities for the university to recruit new faculty and students. ■

Acknowledgements

The FSBC is supported by the Ontario Research and Development Challenge Fund, the private sector, and faculty research grants and other commitments from the University of Guelph. The Canada Foundation for Innovation is providing another $3 million in infrastructure support.

U of G's Food Systems Biotechnology Centre —

Where Philosophy and Science JOIN FORCES

CORIE LOK AND MICHAEL O'HALLORAN

Many philosophical issues arise when other life forms are used to serve human needs. The use of biotechnology in food production is no exception. The University of Guelph's new Food Systems Biotechnology Centre (FSBC) places a priority on ethics in research, and will be looking to a new faculty member from the Department of Philosophy for guidance in careful consideration of this complex topic.

The FSBC's objective is to make use of the tools of biotechnology to secure and expand Canada's food production industry. As described in the foregoing article, some of the Centre's research projects include transgenic plants, DNA chips, improved DNA and protein analysis techniques, and genetically engineered livestock.

The steering committee of scientists developing the FSBC unanimously agreed that an ethics expert was essential to the Centre's operation. Director Alan Wildeman anticipates the ethicist will help the University community stay current with public attitudes towards biotechnology and provide a resource for the public and researchers about issues in the biotechnology debate. Prof. Peter Loptson, Chair of the Department of Philosophy, says that as a faculty member of the department, the ethicist will also teach and publish in the area of bioethics.

Lopston points out that ethics is not just about what is the right or wrong thing to do. Ethics include the principles and arguments that should guide one's thinking when planning a course of action. Awareness of the wide-ranging tools of biotechnology, laws governing such issues as intellectual property protection, and views from Canada and around the world will be an important part of the ethicist's job.

The issue of private funding of research with economic benefits within a university might be one concern an ethicist would want to address, according to Wildeman. Other issues include how science and public concerns should be incorporated into policy governing biotechnology, considerations of risks and benefits, and what types of research projects should have priority in terms of social benefits and values.

Ethics is important to science. In Loptson's view, science is in the business of improving the conditions of life, and this inevitably gives rise to choices involving judgements of value and priority. An example of this is the public notion of what is 'natural' and its preferred value, but differing definitions.

Other institutions such as hospitals have ethicists on staff. They address issues surrounding patient care such as informed consent and patient rights. There is a plan evolving for an Ontario-wide network of university bioethicists dealing with issues involving agriculture as well as medicine. The FSBC ethicist will be a part of this network.

At Guelph, another organization has a long history of paying heed to the questions of ethics. The University's Animal Care Committee is responsible for ensuring the proper care and housing of animals used in research. Prof. Denna Benn, director of Animal Care Services and secretary to the Committee, says there has always been a philosopher on the Committee as a non-animal user representative. For example, Prof. Thomas Settle of the Department of Philosophy looks at the ethics of animal care in the teaching and research program at Guelph.

For his part, Loptson is hopeful the individual chosen as the new ethicist will have a background or experience in science because it will be important for the ethicist to know the nature of the scientific process.

Loptson notes that the use of biotechnology in applied science is a part of a successful Canadian future. The key lies in finding the right balance. ■

Dominating with Domestics

New Genome Manipulation Laboratory will help Canada's livestock industry hold its lead in animal-agriculture genetics

CECIL FORSBERG

The EnviroPig, a weanling shown here among its non-transgenic siblings, is a development with profound implications for the swine industry.

Canada has long held a premier position internationally as a source of livestock genetics, with exports of livestock, gametes and embryos generating $58 million annually. To meet growing and changing demands, the all-new Genome Manipulation Laboratory (GML) — a superior genetic research facility at Guelph — will speed the development of improved strains of domestic livestock.

THERESA RIVETT
AND HEATHER FORBES

World population is estimated to rise another 75 per cent before leveling off at nearly 10 billion. Current food production will have to be doubled to meet demands. At the same time, farmers are being urged to adopt more sustainable and efficient practices. In response, the GML at the University of Guelph will focus on improving the health, productivity, and environmental sustainability of animal agriculture.

Expected to be functional and equipped by September 1, 2000, the GML will be used to develop a select gene bank from which livestock breeders can obtain genetically elite breeding stock. A boon to producers and the industry at large, the gene bank is crucial to ensuring Canada's place at the leading edge of the animal-agriculture revolution. Prof. Cecil Forsberg of the Department of Microbiology is project leader.

The GML will have a number of unique attributes not offered by any other locations at the university. For example, the bi-level laboratory will be constructed in close proximity to a federally inspected abattoir, animal surgical facilities, and animal holding pens. This enables researchers to obtain cells and tissues with minimal delay after slaughter.

The Canada Foundation for Innovation and Ontario's Innovation Trust Fund are contributing $2 million towards the construction of the GML, with an additional $500,000 in in-kind support from Ontario Livestock Industries. A portion of the funding will be dedicated to modifying general animal facilities at Arkell and Ponsonby Research Stations. Two technicians, hired through funding from the Ontario Innovation Trust to the Food Systems Biotechnology Centre, will be on hand to help researchers and students use the advanced laboratory equipment.

Among the principal users of the new lab are 26 researchers from three of the University's colleges. Many of these researchers are

recognized internationally as leaders in their various fields, ranging from biomedical to animal and poultry sciences.

The GML is expected to develop elite, transgenic breeding stock that will be marketed to livestock breeders. These animals may have the capability to increase the efficient use of land in animal agriculture, which will enable diversification of land use to other agricultural purposes.

The EnviroPig

One such animal is the EnviroPig, potentially one of the biggest developments ever in the swine industry. Created by graduate student Serguei Golovan and Prof. John Phillips, Department of Molecular Biology and Genetics (with funding from Ontario Pork), along with Forsberg, the genetically modified pig is designed to have a reduced amount of phosphorus in its manure. Much of the phosphorus in cereal grains is in a form that cannot be digested by pigs, and high levels in their manure can be a significant problem for the surrounding environment, causing nutrient leaching and eutrophication (low in oxygen) of ground waters.

The researchers developed a new gene (called a transgene) by combining genetic material from a mouse with an enzyme-producing gene from a non-pathogenic strain of *Escherichia coli* bacteria. Integration of the transgene into the chromosome of the pig enables the production of an enzyme called phytase in the saliva, which breaks down plant phosphorus in the stomach. It is expected that this will enable the pig to digest all of the phosphorus in plant material.

Estimates based on feeding phytase to pigs have shown that phosphorus in manure can be reduced up to 50 per cent. As well, producers can expect to see a reduction of up to $1.30 per pig due to the decreased need for expensive inorganic phosphorus supplementation.

A number of Yorkshire pigs have been born with the capability of producing the phytase enzyme. Research is underway to determine if the gene can be transferred to offspring and whether pork from the offspring is safe for human consumption.

Other projects that will benefit from the GML include modifying chickens to produce novel products from their eggs, and cloning high-production dairy cows. ■

Acknowledgements

The Canada Foundation for Innovation and Ontario's Innovation Trust Fund are contributing $2 million towards the construction of the GML, with an additional $500,000 in in-kind support from Ontario Livestock Industries.

DAVID BARR

Prof. Cecil Forsberg of the Dept. of Microbiology, University of Guelph, is project leader at the new Genome Manipulation Laboratory.

CECIL FORSBERG

The Ponsonby and Arkell Research Stations are undergoing modification to support the Genome Manipulation Laboratory, funded by government and Ontario Livestock Industries.

CECIL FORSBERG

FROM GENES TO PROTEINS

Equipment and expertise team up for results

Advances in molecular genetics are leading to crops and livestock with more desirable characteristics, and to improved disease diagnosis. The key to future advances is a more precise understanding of how genes operate. At Guelph, new state-of-the-art equipment and a collaborative approach promise long-term benefits for the agricultural industry and consumers.

COREY ALLISON AND
JENNY DOBBIN

DAN VAUTOUR

Fig. 1. Up to 20,000 samples of DNA can be attached to a glass slide, now referred to as a DNA chip.

Genetic research, be it basic or applied, implicates a range of disciplines. In a concerted effort to tap expertise throughout the campus, the University of Guelph has launched the Genes to Proteins project. Led by Prof. David Evans, Chair of Molecular Biology and Genetics, the project brings together 17 faculty from six departments. Genes to Proteins should help broaden the learning potential for genetic research, and expand the applicability of results.

And thanks to a $1-million award from the Canada Foundation for Innovation, as well as in-kind and partner support, researchers will have at hand leading-edge equipment for interdepartmental studies.

Whether it is a study to improve weight gain in pigs or to trace evolution in fish, a significant portion of what is studied on campus ultimately relates back to genes. For example, research in a department like Molecular Biology and Genetics that is designed to study basic gene function can help applied research in topics such as drought and cold tolerance.

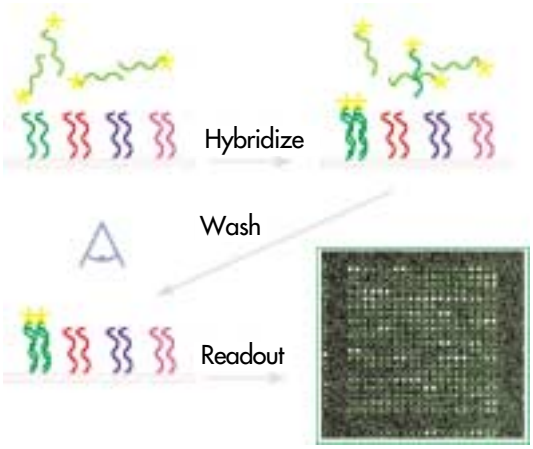
A better understanding of the link between genes and proteins, and how genes determine an organism's structure, will lead to a better understanding of how an organism functions.

The new equipment includes a Biacore machine, a gene arrayer and chip reader, computers for genetic modeling, and upgrades for existing DNA sequencers.

The much anticipated DNA arrayer and chip reader is a robot capable of movement in very fine steps (see sidebar and Figs. 1 and 3). Researchers can use it to attach 10,000 to 20,000 samples of DNA — molecules found in the nucleus of cells that encode genetic information — to a single glass slide. This slide can then be used to test which genes are activated, or expressed, as a result of various treatments such as pesticide application or changes in water availability.

Working with Dr. Shu Chen, new technology development leader at the Guelph Molecular Supercentre, Evans also plans to use the arrayer to explore better ways of detecting and identifying pathogenic viruses. This could speed up and improve the quality of plant and animal disease diagnosis and possibly reduce costs to farmers.

Genetic research of this type can also be applied to improving characteristics of domestic animals. Ontario has a global reputation for high quality livestock. Arrayer



DR. D. EVANS. CHIP COURTESY DR. J. WOODGETT.

Fig. 2. RNA is extracted from a plant or animal cell, labelled with fluorescent molecules, and hybridized to the DNA fixed to the chip surface. This creates a fluorescent spot on the readout.

technology might help to ensure this leading-edge reputation endures. By improving our understanding of gene location and identity, we can learn what gives our livestock the advantage and how that edge can be enhanced.

Similar principles can also be applied to improving plants to meet farmers' needs. Exposing plants to temperature extremes, water level variations, and even pesticides or herbicides can lead to the identification of the genes responsible for plant adaptation. One possible outcome is plants with increased tolerance to cold, toxic metals, or improved drought resistance.

The new Biacore Spectrometer allows researchers to measure the affinity one molecule has for another, e.g., how an antibody binds to the antigen. Also being upgraded are confocal fluorescence microscopes, commonly used for locating particular molecules or proteins within a cell. By knowing where they are, it is possible to figure out what they do.

The computers that will be part of the new initiative enable researchers to perform advanced data analysis techniques. For example, molecular modeling programs use graphics to study the structures of proteins. Genomics (computer-based programs for comparison and interpretation of DNA and protein sequence data), are used to analyze DNA sequences to determine what they encode and what they do.

The departments involved in the research represent the Ontario Agricultural College, the College of Biological Sciences, and the College of Physical and Engineering Sciences. Though the installation and management of each new item will be the responsibility of individual faculty members, the new additions will be available for use by anyone on a cost-recovery basis. ■

DAN VAUTOUR

Fig. 3. Dr. Jiping Li of the University of Guelph examines the readout from the gene arrayer. Together with a DNA chip reader, thousands of DNA samples can be rapidly tested to determine which genes are expressed in response to various treatments.

Acknowledgements

The Canada Foundation for Innovation Awards awarded a $1-million grant for new equipment to aid genetic research.

DNA, RNA, and the function of the gene arrayer

When genes are activated, RNA (ribonucleic acid) is produced to transfer the instructions encoded within the gene to the ribosome. Within the ribosome, the sequence of the RNA is read out as a protein.

At the heart of an arrayer is a small glass slide bearing up to 20,000 spots (segments) of DNA. Each spot contains a different DNA, the identity of which can be determined from its grid location. This DNA chip is combined with or 'hybridized' to fluorescent copies of the RNA extracted from the plant or animal cell (Fig. 2). Wherever the fluorescent copy finds a DNA with the same sequence a fluorescent spot is formed.

Measuring the intensity of the fluorescence in a chip reader tells how much a gene is expressed; measuring changes in fluorescence indicates how gene expression responds to the environment.

Hedley Technologies Inc.

Bio sciences company on the discovery trail for alternative, natural pesticides

Fig. 1. Protect-It® structural application using compressed air gun. Effective pest management is critical in storage, shipping and processing facilities.

The loss of stored grain to insects is a vexing problem worldwide, especially in tropical climates. Protecting a stored foodstuff from pests is no simple matter either, given that it is so close to a final food product. Hedley Technologies of Mississauga went underground to find a safe solution. Now its successes are taking it around the world.

Worldwide, an estimated average of 20 per cent of food crops (ranging from 10 to 50 per cent) is destroyed by pests during the post-harvest period. In the United States, post-harvest food losses to pests are estimated at less than 10 per cent. Elsewhere in hot humid climates, as in parts of China, India and Pakistan, losses can be significantly higher.

Meanwhile, conventional means of pest management are facing resistance on two fronts. Pests have developed resistance to common chemical insecticides (e.g., malathion) and fumigants (e.g., phosphine), and consumers and governments are generally concerned by the effects of agrochemical use on human and environmental health.

In 1992, Hedley Technologies Inc. began selling a home-and-garden insecticide based on diatomaceous earth or DE. DE is a mineral composed of fossilized single-celled phytoplankton called diatoms (Fig. 3). A natural biological agent, the powdery substance absorbs the outer waxy layer on the insect's cuticle. As this protective layer is absorbed, the insect dehydrates and dies (Fig. 2).

Hedley soon saw potential for DE in post-harvest grain protection, and worked with Agriculture and Agri-Food Canada (AAFC) in Winnipeg to develop and test a new formulation. The research demonstrated that the combination of DE and amorphous silica or silica gel is synergistic, and the new

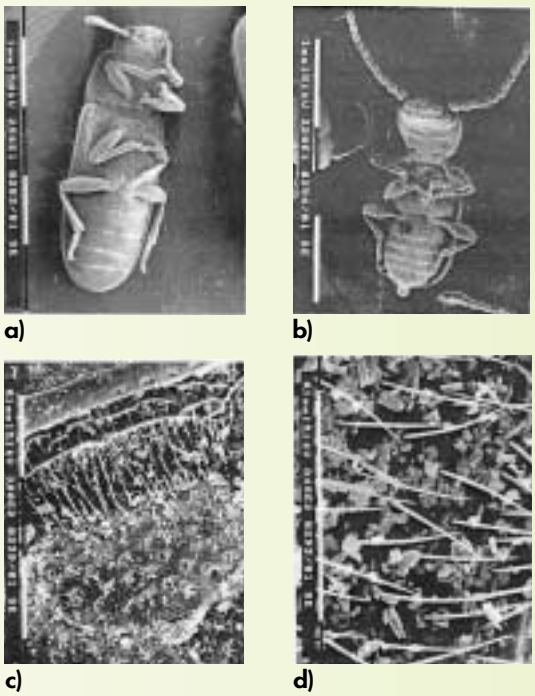


Fig. 2. Scanning Electron Micrograph (SEM) of Protect-It® adhered to the epicuticle of insect specimens. a) Protect-It® on surface of insect. b) Protect-It® on surface of insect (lower magnification). c) Protect-It® adhered to *Cryptolestes* spp. d) Protect-It® adhered to *Tribolium* spp.

formulation significantly outperformed other insecticides that used DE as their sole active agent (Fig. 5). Protect-It® is now used in silos, elevators, mills, warehouses, truck-trailers, rail cars, ships, and processing facilities, and for direct application to grains and seeds (Figs. 1 and 4).

Inventors Dr. Zlatko Korunic of Hedley and Dr. Paul Fields of AAFC patented the product, which in turn led to the signing of a Technology Licensing Agreement in 1996. The agreement gives Hedley exclusive rights to

commercialize Protect-It® worldwide in return for a royalty based on sales. The agreement provides for a 50:50 ownership of the technology, and sharing of costs related to patent applications around the world.

Having achieved broad acceptance throughout North America, the product is now being introduced in Asia and Europe. Protect-It® is in the process of gaining regulatory approval in Pakistan, where it is expected that it will provide a safe and effective means in helping

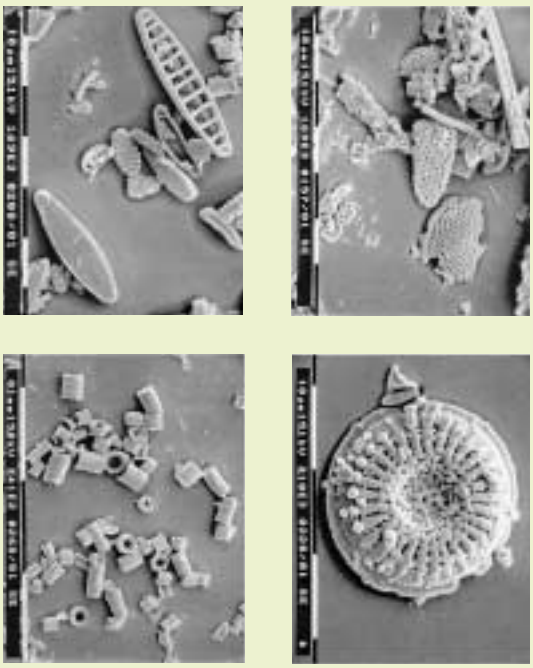


Fig. 3. SEM of various diatomaceous earth samples indicating differences in shapes and sizes among diatom species.

prevent severe grain storage losses in that country. Access to the Chinese market, where the product registered, is also highly prized: With 400,000,000 tonnes, China has the biggest grain storage market in world.

Hedley Technologies Inc. is one of a small handful of Canadian companies that seeks to develop new pesticides for agriculture. According to Rene Goehrum, Chairman and CEO of Hedley, the company's vision is to create the world's leading integrated producer of agricultural inputs based primarily or exclusively on materials of biological origin.

In-house R&D is a key component of the company's technology development strategy. In addition to its own R&D operation located in Guelph, Hedley seeks collaboration as a means of better appreciating industry needs, research priorities and technical resources. Relationships are struck with laboratories connected with universities, government research organizations, and small private companies.

Its first project with the University of Guelph explored the use of a DE-based preservative to promote growth when fed to starter pigs. Led by Prof. Trevor Smith of the Department of Animal and Poultry Science, the research showed the addition of Protect-It® to feed rations promoted growth.

Research with the University of Guelph showed that the addition of the diatomaceous earth-based preservative to feed rations promoted growth in starter pigs.

Research into novel, low-toxicity insecticides for use in agriculture continues to be Hedley's focus. Last fall, the company research team led by Korunic completed a two-year in-house project with support from the National Research Council's Industrial Research Assistance Program. The project saw the development of two new broad-range insecticides that use a complex, multiple mode of action to control a wide variety of insects, and yet are virtually non-toxic. F2, one of the new insecticides, will be registered for structural use and for direct application to stored wheat. Research continues on both products, in

Fig. 4. On-farm Protect-It® grain application at harvest. The product is now being introduced in Europe and Asia to prevent severe grain storage losses due to insect infestation.

anticipation that the technology can be extended beyond post-harvest grain protection to field crops, horticulture, greenhouses and domestic use. A patent is in process.

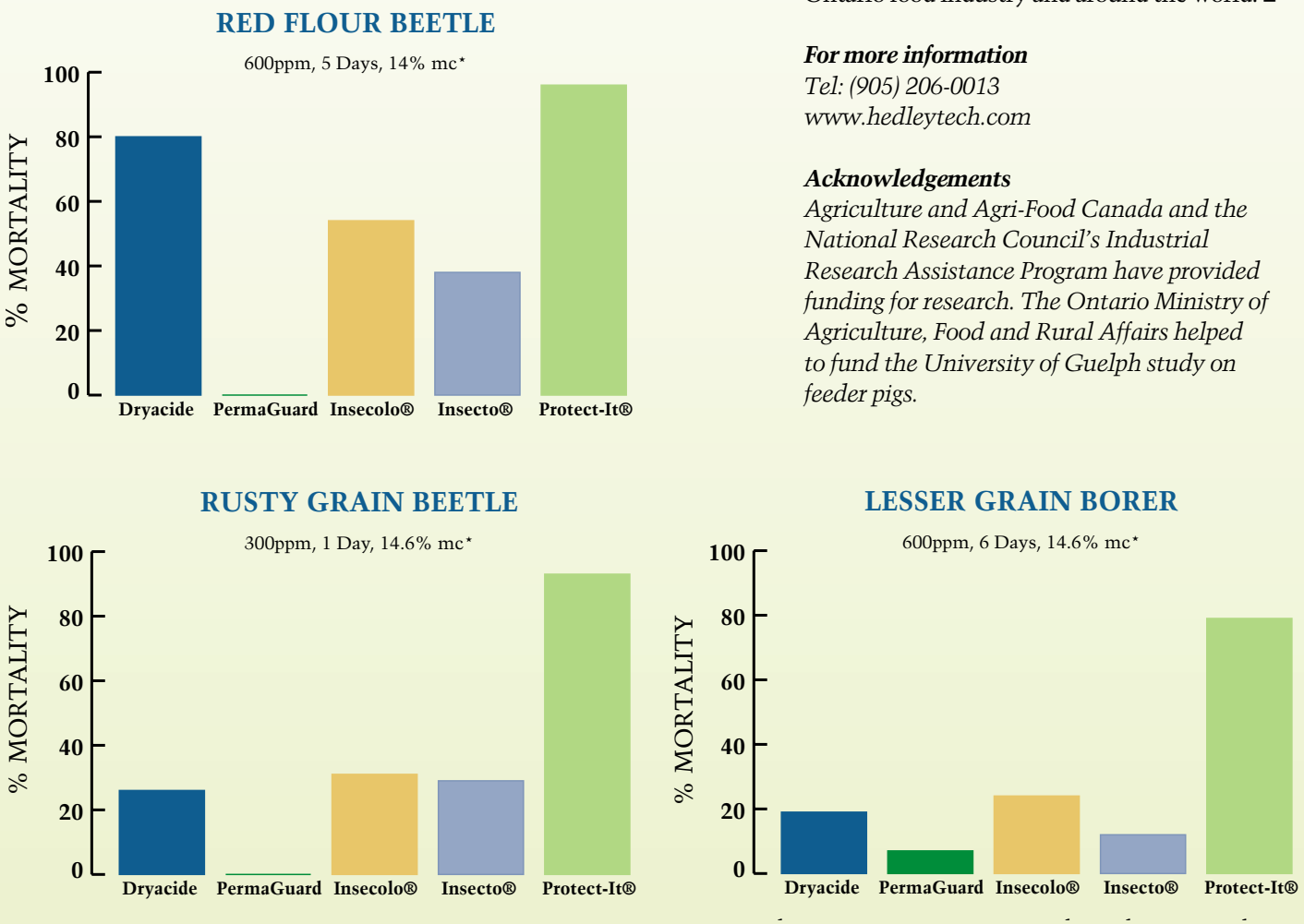
Eventually Hedley hopes to develop an 'all natural' insecticide whose efficacy matches or exceeds that of conventional insecticides, and can be used in both organic and conventional agriculture.

Developing new pesticides, especially for post-harvest use, is particularly tricky, yet never more in demand. Countries importing grain set increasingly stringent demands for food safety. Japan, for example, tests for over 50 types of chemical residues. Still, global demand for grain will grow steadily, as the world's population grows by 90 million annually and arable land is steadily lost. And infestation rates will remain steady or possibly increase, especially as conventional means of pest control lose efficacy or fall out of favour.

The challenge for Hedley Technologies is to meet the demands of the industry in terms of product safety and effectiveness while at the same time providing products with little or no impact on food safety. Through innovative, collaborative research, strategic alliances and venture capital, Hedley hopes to develop and market sustainable technologies for the Ontario food industry and around the world. ■

For more information
Tel: (905) 206-0013
www.hedleytech.com

Acknowledgements
Agriculture and Agri-Food Canada and the National Research Council's Industrial Research Assistance Program have provided funding for research. The Ontario Ministry of Agriculture, Food and Rural Affairs helped to fund the University of Guelph study on feeder pigs.



*mc denotes grain moisture content

Fig. 5. Protect-It® is compared to other DE-based pesticide formulations against three stored product insects at 30 deg. C, 14.6% moisture content on wheat. All products are registered in the United States. Insecolo® (Hedley's home-and-garden product), Insecto® and Protect-It® are registered in Canada.

Agricultural Plant Biotechnology Centre

JULIE EISSES AND
JULIE HAWTHORNE

Collaboration makes the right environment for innovations

The commercialization of agri-food products for world markets will be more efficient, thanks to a collaboration of plant biotechnology research interests at the University of Guelph.

Research at the Agricultural Plant Biotechnology Centre is aimed at developing and applying innovative methods in plant biotechnology to improve crop productivity and utility. Working from several laboratories, 13 faculty members as well as graduate students and research technicians will be advancing cellular and molecular aspects of pest resistance, stress tolerance, photosynthesis enhancement, and yield potential for various crops.

The anticipated benefits are many and varied. The presence of a larger group of researchers with common interests is expected to attract multinational and local companies, and put the Centre in the vanguard of biotechnological research relevant to the agricultural industry. It should also enhance training opportunities for future experts. With a variety of researchers having access to common equipment, funds can be saved and more time devoted to discovery.

Canada Foundation for Innovation (CFI) funding of $1.6 million will support the creation of the Centre. Prof. Peter Pauls, an expert in plant tissue culture and molecular biology, will lead the project.

New scientific equipment will be purchased, and there will be a consolidation of equipment that was previously housed in separate locations throughout campus. Among the new purchases will be a DNA sequencer, a DNA chip scanner, an ultracentrifuge and rotors, a DNA extraction robot, microscopy

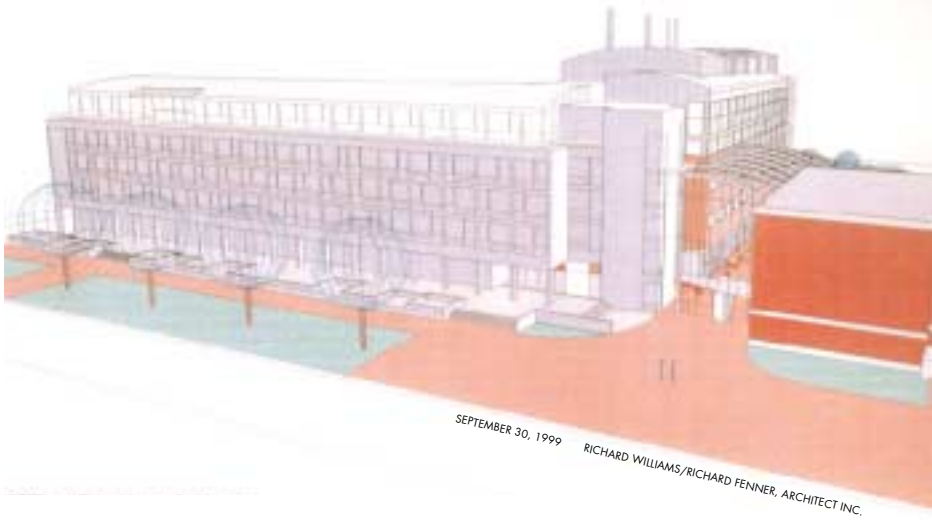


Fig. 1. Renovations for the Agricultural Plant Biotechnology Centre will include the addition of a fifth floor to the Crop Science building, and a five-storey addition to house new state-of-the-art biotechnology labs and genomics equipment.

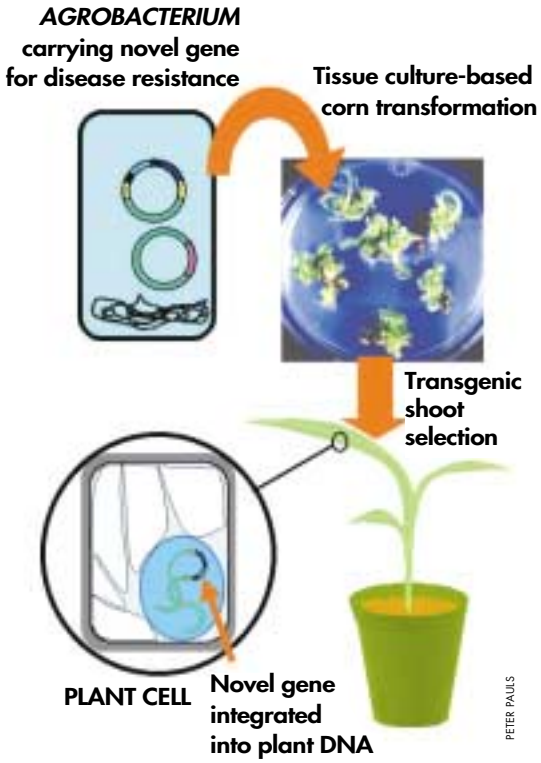


Fig. 2. The Agricultural Plant Biotechnology Centre is using plant transformation to produce corn that is resistant to *Fusarium* infection, a challenge of enormous significance to corn growers, livestock producers, and processors.

and digital imaging equipment, and a mass spectroscopy station.

Major changes to the Crop Science building and surrounding area are expected (Fig. 1). The proposal includes the addition of a fifth floor to the existing building and a new five-storey extension to be built on the back of the Crop Science building. The existing transgenic greenhouse facility will be doubled in size.

The CFI grant along with a matched grant of $1.6 million from the Ontario Innovation Trust will provide the infrastructure support for equipment, renovations, and additions to the Centre. These changes will allow for state-of-the-art biotechnology labs, the housing of plant biotechnology, and genomics equipment.

Fostering *Fusarium* resistance

In Pauls' laboratory, collaboration is an important part of a multi-year project to increase the resistance of corn to *Fusarium* ear mold — a fungus that infects corn, leading to the accumulation of toxins in the grain. The fungus can cause animals to reject their feed and in severe infections, cause reproduction problems in animals that ingest the toxin-containing corn. Along with researchers in Profs. Ken Kasha's and Elizabeth Lee's groups, and with collaborators from Agriculture and Agri-Food Canada (AAFC) in Ottawa, Pauls' team is developing biotechnological approaches to produce and select corn that is resistant to fungal infection.

Pauls' lab is using methods to increase *Fusarium* resistance and reduce the toxin content of corn — plant transformation and molecular marker-assisted selection (Fig. 2).

A plant transformation technique to insert novel genes for disease resistance relies on the ability of a soil microbe called *Agrobacterium* to 'naturally' transfer genes into plants. After genetically modifying the bacterium to contain the novel gene, it is co-cultivated with corn tissue cultures. Corn shoots that have been transformed by the interaction with the *Agrobacterium* are regenerated into plants that contain the stable-incorporated novel gene. The work in Pauls' lab is focused on improving the transformation procedure, which currently is very inefficient with corn. In the second stage, transgenic corn with disease-resistance genes will be produced using the improved methodology.

His team is also exploring the use of molecular markers to select naturally occurring *Fusarium* resistance in corn. Selection of resistant corn by conventional field-based inoculation methods is labour intensive, time consuming, expensive and highly affected by climatic conditions during the establishment of the disease. The identification of molecular markers linked to the disease resistance genes will make it possible to identify corn lines in breeding

programs that are carrying resistance genes, on the basis of a DNA test in the laboratory. The advantages of this approach are that the DNA test can be done at the seedling stage and it is relatively fast and easy.

Pauls' group is identifying DNA markers that are linked to disease-resistance genes in a population derived from a cross between a resistant parent identified by Lana Reid at AAFC and a susceptible parent from the Guelph breeding program (Fig. 3). Once the associations between the DNA markers and resistance genes are established, it will be simple to breed corn by selecting resistant lines, on the basis of the presence or absence of the markers.

Toward marketable plant products

Other projects with the Agricultural Plant Biotechnology Centre include the development of drought-tolerant turfgrass and other value-added perennial grasses in Prof. Stephen Bowley's lab. His colleague in Plant Agriculture, Prof. Judy Strommer, and her team are working on oral vaccine production in plants, while Prof. Larry Erickson of the same department is developing edible health technologies for human and veterinary applications such as edible vaccines, peptide antimicrobials, and growth factors.

The new Centre should ensure marketable products developed more efficiently — a benefit shared by producers, processors, and consumers. ■

Acknowledgements

The Agricultural Plant Biotechnology Centre is being sponsored by the Canada Foundation for Innovation and the Ontario Research and Development Challenge Fund. The Natural Sciences and Engineering Research Council is donating funds for equipment. The Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) is supporting this initiative through ongoing funding for research interests of faculty. Prof. Pauls' work on Fusarium *is supported by the Ontario Corn Producers' Association, Ontario Pork, OMAFRA, AAFC, CanAdapt, and a consortium of corn seed companies.*

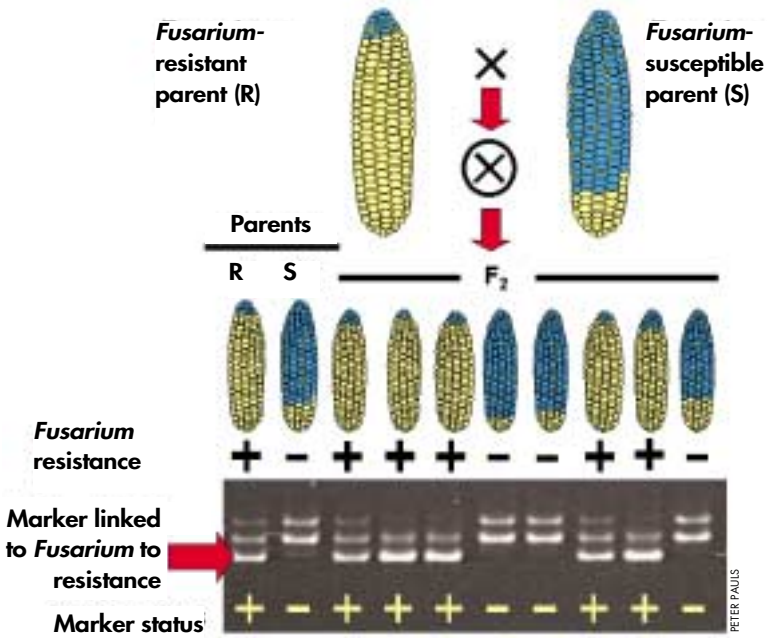


Fig. 3. Project leader Peter Pauls' lab is developing the use of molecular markers to select corn with naturally occurring *Fusarium* resistance. The first step is to cross a *Fusarium*-resistant parent with a susceptible parent. DNA markers linked with *Fusarium* resistance can be then be identified and characterized. The presence of these markers in DNA analysis would indicate resistance, which will allow for the selection of resistant lines for corn breeding.

Cold-tolerant corn

Molecular markers help map out corn trait locations

From lab to field to fork sooner: new molecular technologies are increasing the efficiency and speed of plant breeding research. A University of Guelph corn breeder is using molecular markers to fast-track the development of stronger, cold-tolerant corn varieties.

STEVE JONES
AND AMY BOAL

The presence of specific genes in a corn plant's DNA influence how well or poorly it will perform under various conditions.

Plant Agriculture Prof. Elizabeth Lee's focus is on identifying corn plants that naturally do well under the cold temperatures that often occur in Ontario during the seed-filling months. She is using molecular markers to identify the specific genes that are responsible for cold- tolerance. Once those genes are identified, corn varieties exhibiting the greatest cold-tolerance characteristics can be specifically selected for breeding.

Molecular marker technology speeds the rate and efficiency of breeding because once the genes of interest are identified, experimental plants can be screened for them without being grown to full maturity — a slow and time-consuming process.

Prof. Lee likens a chromosome to a road, and molecular markers to road signs that indicate the distance from a particular gene. Molecular markers are placed on either side of a gene to pinpoint its exact location on a chromosome.

Cold night temperatures late in the growing season can substantially hamper corn yields. Corn plants decrease their photosynthesis activity (whereby the sun's energy is converted into energy that is deposited in the kernel during the grain fill period) when temperatures fall below 10° C overnight. That is a problem in Ontario, where approximately a third of August nights and two-thirds of September nights dip below this temperature.

Some commercial hybrids are sold for short growing seasons and are popular with Ontario corn producers. Lee's goal is to identify the chromosomal regions responsible for cold tolerance in these hybrids so that more inbred lines can be developed with that trait in particular.

She is screening corn plant parents that are either highly tolerant or sensitive to cold temperatures by growing them hydroponically at the Cambridge Research Station. The plants are placed in a freezer to subject them to cold shock, and their decrease in photosynthetic activity is measured (Fig. 1).

So far, Lee has found the percentage of photosynthesis reduction can vary significantly among different corn hybrids that have been exposed to a cold treatment for 16 hours (Fig. 2).

Once screening is complete, parent plants exhibiting cold tolerance will be crossed to draw genetic linkage maps for the cold

HYBRID	FIVE WEEKS AS (accumulation of moisture, %)	SIX WEEKS AS (serum titre)
PRIDE 5	34.7a	43.0a
PIONEER 3902	23.1b	29.5b
CARGILL 1877	17.1c	20.2c

Fig. 2. Prof. Lee has found that following a 16-hour cold treatment, the per cent reduction in photosynthesis varies among hybrids. She expects that cold tolerance won't be attributed to a single gene, since photosynthesis is a complex process of many proteins and biological systems.

tolerance trait. Lee suspects cold tolerance won't be attributed to a single gene. That is because photosynthesis is a complex process that depends on the activities of a number of proteins and biological systems.

Lee underlines the importance of pinpointing which genes are involved in cold tolerance. That information can be used in screening and selecting parent plants that will allow breeding of cold tolerance lines without relying on transgenics.

Related corn breeding projects involve mapping corn chromosomes for flavonoid and white food corn traits. ■

Fig. 1. For Prof. Lee's cold-tolerant corn study, the corn plants are grown in pails, then placed in a freezer to measure the decrease in photosynthesis after exposure to cold temperatures.

Acknowledgements

Prof. Lee's work on cold tolerance is sponsored by the Ontario Corn Producers' Association, Novartis, Pioneer Hi-Bred Ltd., and Agriculture and Agri-Food Canada through the CanAdapt program (administered by the Agricultural Adaptation Council). She also received funds for this project through the Canada Foundation for Innovation New Opportunities Fund. Along with her colleagues François Tardif and Istvan Rajcan, Department of Plant Agriculture, Lee was granted the New Opportunities award — designed to provide infrastructure support to new researchers — to research molecular marking technology in plant breeding and weed science.

Rapid Plant Genetic Transformation

Until recently, it's taken up to a year to produce the first generation of transgenic plants. Two generations in a year is now possible, thanks to a new technique developed at the University of Guelph.

MASSIMO SANAGO

a)

b)

c)

Fig. 1. Somatic embryogenesis in transformed soybean plants. a) Somatic embryos at various stages of development. b) Developing embryo with shoot and root apex. c) Developing plantlets from somatic embryos.

By using specific plant tissues and growth conditions, Prof. Massimo Sanago of the Department of Plant Agriculture has significantly improved the methods used to transform plants. This new protocol is more rapid and efficient by 10 to 30 per cent in peas, five to 10 per cent in soybeans, and 35 to 50 per cent in alfalfa.

In addition to accelerating the availability of transgenic plants — a boon to researchers in itself — the new protocol can also be used to transform many varieties of soy, peas, and alfalfa. Conventional transformation methods are limited to only a small number of varieties within a plant species.

There are two methods commonly used to produce a transgenic plant: *Agrobacterium*-mediated transformation, and particle gun bombardment. The new protocol improves the otherwise low efficiency of both systems by using the hypocotyl, the part of the plant located between the cotyledons and the root. To date, no other reports have indicated the hypocotyl had been successfully used in pea and alfalfa plants.

Prof. Sanago has found a way to regenerate plants more efficiently by using specific tissues and a defined growth medium to induce somatic embryogenesis — a pathway that gives a greater number of shoots from a somatic cell in a shorter period of time.

engineering of plants made faster

CORIE LO

MASSIMO SANAGO

Fig. 2. Production of multiple shoots from the hypocotyl by somatic embryogenesis in transformed alfalfa plants. The specimen on the far left shows developing plantlets from somatic embryos.

MASSIMO SANAGO

a) b) c)

Fig. 3. Production of multiple shoots from the a) pea hypocotyl, b) epicotyl, c) cotyledons. The new protocol developed by Prof. Sanago is much more efficient in transforming plants and can also be used for many varieties of soy, peas and alfalfa.

The new, relatively straightforward method of transforming and regenerating plants is expected to be used by both the public and private sector. A patent application has been filed. ■

Acknowledgements

This research was supported by the Ontario Ministry of Agriculture, Food and Rural Affairs and the Ontario Soybean Growers' Marketing Board.

TAKING THE CHILL OUT OF TOMATOES

Tastier, hardier produce for the fresh market and processors

Ontario has a short growing season for field tomatoes. And because tomatoes are highly perishable, they can't be stored for very long. Food processors must import their supply of vegetables for most of the year. Soon, with the help of new technology, the province's growers will have a better shot at the competition. Tastier, firmer field tomatoes with longer shelf-life and improved quality and chilling tolerance are being developed by University of Guelph researchers.

CAROL PILLEY

Food Science Prof. Gopi Paliyath and research associate Kurt Almquist predict these tomatoes could have double or triple the normal shelf-life. Potentially, they could ripen on the vine for a longer period of time and tolerate refrigeration before processing, without compromising quality and nutritional value. The goal is to provide consistent and long-term availability of Ontario-grown field tomatoes both for the fresh market and processing industry.

The first step towards improving the shelf-life and quality of tomatoes is to understand the mechanism that causes tomatoes to perish. In previous research, Paliyath found the pathway involved in cell membrane degradation — known as the phospholipid degradation pathway — is a key factor causing tomatoes and other perishable fruits and vegetables to deteriorate.

Tomatoes are highly sensitive to cold temperatures; untimely exposure to chilling stress results in poor quality tomatoes. Exposure to cold stress triggers the activity of phospholipase D, an enzyme that initiates cell membrane degradation.

Paliyath and Almquist are trying to inhibit the activity of phospholipase D to prevent or slow down degradation of the cell membrane. First, they are attempting to regulate the enzyme's activity, using molecular biology techniques. To that end, the gene that codes for phospholipase D is removed, copied and then reinserted into the tomato in reverse — a method known as anti-sense technology. This could turn off the action of phospholipase D and inhibit the degradation of the cell membrane, leading to a genetically altered tomato with increased shelf-life, quality, and other potential features such as chilling

tolerance, that would make it suitable for long-term storage.

On the surface, the researchers' technology sounds a bit like the Flav'r Sav'r tomato — the first whole-food biotechnology product — but there are important differences. The Flav'r Sav'r has been genetically altered to slow the softening process by blocking a different enzyme that breaks down the cell wall. The result is that the tomato can ripen for a longer period on the vine and still retain firmness during transport. But the cells continue to degrade, resulting in a tomato that may lack flavour and eating quality.

The researchers say this will not be the case with the new tomato variety. The degradation of the cell membrane is inhibited, so nutrients stay within the cells. In plants, the cell wall provides structural support for the cell and the cell membrane regulates what moves in and out. Cellular contents, such as nutrients, are better preserved if the integrity of the cell membrane is maintained.

Paliyath expects these tomatoes will remain firm during transport because enhancing the integrity of the cell membrane will also improve the quality of the cell wall.

In future, Paliyath and his associates hope to use this method to improve shelf-life, quality, and chilling-tolerance of other fruits and vegetables including peaches, plums, cherries, peppers, potatoes, and leafy vegetables. ■

Acknowledgements

These studies have received major funding from the Ontario Ministry of Agriculture, Food, and Rural Affairs.

The stress of chilling

Cold temperatures can have adverse effects on plants, greatly jeopardizing their commercial value. One of the greatest impacts of chilling occurs during post-harvest storage. While some fruits and vegetables are refrigerated after harvest to maintain quality, others such as tomatoes are not.

The normal ripening process of the tomato is impaired if it is exposed to cold temperatures. This is why it is always recommended that consumers store their store-bought tomatoes at room temperature and not in the fridge. Exposing tomatoes to cool temperatures also affects their taste and colour.

Other fruits and vegetables that do not store well at cool temperatures include bananas, avocados, melons and peppers.

Public Research → Commercial Technology
Growing the Ontario Agri-Food Industry

Performance Plants Inc

Hardier, more nutritious crops for the globe thanks to home-grown technologies

Genetically modified alfalfa.

Performance Plants Inc. is in the business of developing novel plant biotechnologies for some of Canada's major crops. The company is itself one of a growing number of novel and successful hybrids of public and private research efforts.

Researcher Maryse Chalifoux artificially fertilizing canola plants.

David Dennis, President and CEO of Performance Plants Inc.

Performance Plants was founded by members of the plant biology group at Queen's University in 1995. Pooling their expertise in plant metabolism and morphology, colleagues Dr. David Dennis and Dr. Daniel Lefebvre transformed their expertise into a business with headquarters at Queen's and a branch research facility in Saskatoon. The venture got underway in part with the help of PARTEQ Innovations Inc., the technology transfer arm of Queen's.

Former Head of the Biology Department at Queen's and now President of Performance Plants, Dennis's specialty lies in primary plant metabolism and cellular compartmentation. Lefebvre, the company's Vice-President, remains a professor at Queen's, and is a molecular biologist and an expert in the areas of mineral nutrition and energy metabolism of plants. They maintain a staff of approximately 30.

Performance Plants focuses on the use of metabolic engineering to develop higher-producing plant varieties with improved nutritional quality and improved tolerance of environmental stresses such as water stress. Canola, alfalfa, soybean and corn have received particular attention, although some of the technologies they have developed can be applied to a wide range of food crops and cotton.

Much of the work at Performance Plants begins with basic research. Its team develops and tests its strategies until they are shown to be effective in field trials of new varieties. At that stage, the resources of a larger corporate partner are sought to help finalize the technologies and bring them to market. One such example is the $2.2 million research and marketing partnership that Performance Plants struck two years ago with Dow AgroSciences Canada Inc. Dow AgroSciences wanted to see further development of GET™ and AMPLE™ genes (described below) to increase crop and oil yields on a range of oilseed crops and silage corn.

Here is a summary of technologies developed by Performance Plants.

Growth Enhanced Technology (GET™) Most plant yields decrease under low light conditions such as leaf canopies. GET offers a means of promoting greater and faster growth. Performance Plants has developed transgenic lines of alfalfa, tobacco, lettuce, and canola. In addition to higher yields generally, the technology should allow more intensive cultivation, be advantageous to greenhouse-grown crops, and possibly improve colour retention.

Augmented Microbial and Plant Expression (AMPLE™). AMPLE genes promote higher crop and oil yields in several Canadian crops. Performance Plants has found a way to enhance the synthesis of desirable compounds in plant cells. Through AMPLE, the capacity of plastids to import enzymes is increased, and thus the synthesis of starch, oil and protein is improved. AMPLE technology has been applied to canola, alfalfa, soybean and corn. There may also be an application in pharmaceuticals, as AMPLE has demonstrated increased protein export in bacteria, which are used to produce large quantities of proteins.

Water stress tolerance. Drought is of worldwide concern, especially for farmers who experience significant crop losses due to water shortages. Developed in collaboration with the University of Toronto, this patented technology seeks to slow water loss from plants. Loss occurs mainly through the stomata of leaves, which are tiny pores that control the flow of gases and moisture. Performance Plants has an exclusive license to a gene that is involved in the control of stomata closure. Crop applications include canola, soybean, corn, wheat, barley and potato.

Nutritional quality. The presence of lignin or fibre content in animal feed derived from oilseeds such as canola diminishes the feeds' nutritional quality. Performance Plants uncovered a means of modifying the biosynthesis of the lignin in the seed coat of a plant so as to reduce its fibre content.

Phosphate stress technology. Altering a plant's ability to use available phosphate can enhance growth, cause alterations in flower and root development, and modify phosphorous-containing compounds in organs and seeds. One of Performance Plants' proprietary technologies involves the controlling mechanisms that enable plants to cope with changing phosphate levels. Several genes have been cloned and transgenic lines of a research plant have been generated.

Enhanced oil synthesis. Growers of canola and other oilseed crops will be interested in this technology, which increases levels of oil stored in the seed. By genetically modifying oilseed metabolism, the flow of metabolites into fatty acids, and subsequently the oil content, are enhanced. Performance Plants has produced transgenic plants with changes in a number of enzymes involved in seed carbohydrate metabolism.

The presence of Performance Plants Inc. at Queen's is mutually beneficial. Performance Plants draws its roots from many years of fundamental research at the university. In turn, the accomplishments of Performance Plants attracts investors, researchers, and jobs to Queen's and the surrounding community. At the same time research and technology are being fostered that offer important improvements and products to farmers, processors, and consumers. ■

Greenhouse Manager, Daphne Boyce, threshing canola plants.

Researcher Linda Tremblay preparing plant samples for analysis. Research focuses on the use of metabolic engineering to develop plant varieties with improved nutritional qualities and improved tolerance to environmental stresses.

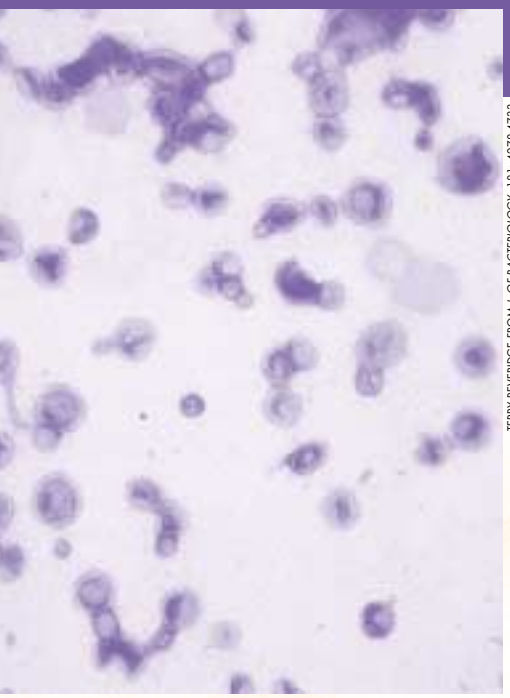
For more information
Tel: (613) 545-0390
www.performanceplants.com

Acknowledgements
The studies at Performance Plants Inc. are supported in part through the Natural Sciences and Engineering Research Council. The Saskatchewan government also provides funding through the Agri-Food Innovation Fund and Industrial Research Assistance Program.

Special Delivery

vesicle technology the way of the future for vaccines and antibiotics

New alternatives for vaccine and drug delivery may be just what the doctor ordered to combat antibiotic-resistant strains of bacteria and for improved, economical vaccines.



TERRY BEVERIDGE FROM *J. OF BACTERIOLOGY*, 181: 4278-4733.

Fig. 1. Negative-stained membrane vesicles isolated and purified from *Pseudomonas aeruginosa*.

CAROL PILLEY

Prof. Terry Beveridge, Department of Microbiology, is heading a promising project using something called membrane vesicles — small sac-like structures — to deliver both vaccines and antibiotics to tissues and cells. The research on this novel technology is well underway, and with the help of his microbiology research team, Beveridge is covering the gambit from basic research to development of the applied technology.

Here is the basis for his research. There are two fundamental varieties of bacteria, gram-positive and gram-negative, which differ in the structure of their cell wall. Unique to gram-negative bacteria is their constant shedding of membrane vesicles from their surfaces.

The vesicles are pinched off the surface of the bacteria and maintain the original outer membrane structure of the bacterium. As the vesicles pinch off, they entrap small bits of the periplasm (the gel-like matrix between the membrane and cell wall), including different enzymes, proteins, and other components that were present in the original bacterium.

One thrust of Beveridge's research is a vaccine delivery system using the membrane vesicles. This new technology could help to improve the effectiveness of vaccines against a range of diseases in humans and animals. So far, the results are looking positive, and associate Dr. Hongwen Fu is conducting further laboratory tests.

The vaccine delivery system is based on the periplasm entrapment feature. On the cell wall are antigens, substances that cause an immune response when the infected organism identifies them as 'foreign.'

Pathogenic bacteria are highly immunogenic, meaning they can evoke a strong immune response within the organism they are infecting. This makes them good candidates to use as vaccines, which are microbial preparations that stimulate an immune response in another organism to prevent future infection with a similar microorganism.

Although these vesicles (shed from pathogens) provide a unique 'fingerprint' of the bacterium, making them promising vaccines, they present one obstacle: On their membranes, there are toxic chemicals called endotoxins. This toxicity means the vesicles cannot simply be injected into an animal or human, or they would promote a fever.

The solution is use live bacteria that are attenuated, which means they have lost their virulence or toxicity, to deliver these vaccines to the tissues. Some live, attenuated bacteria are approved for use as vaccines by the federal government, such as some *Salmonella* strains.

Here is how the attenuated bacteria solution works. The researchers use their own technology to fuse the membrane vesicles of the pathogen into an 'approved' live, attenuated bacterium, such as *Salmonella*. The vesicle melds into the surface of the *Salmonella*

bacterium, exposing the antigens (Figs. 1 and 2). This stimulates an immune response by the organism, which recognizes the disease-causing microbe, and launches a counterattack before illness can occur. The result is immunity.

Ideally the live, attenuated vaccine would be given to a patient orally, rather than by injection. It would remain alive in tissues such as gut epithelium, hiding and waiting...all the while eliciting an immunity if any pathogen dares attack.

A unique advantage of this technology is that any number of vesicles from strains of pathogenic bacteria can be added to the vaccine, providing immunity against all of them. The vaccine delivery system is also easy to prepare, compared to the genetic manipulation techniques commonly used for vaccines today.

Beveridge believes this new technology rewrites the book on vaccines for gram-negative pathogens. It is an easy, economical, and effective vaccine technology that could prove very useful for both the agricultural animal and medical vaccine industries.

Delivering the goods

With the emergence of new strains of antibiotic-resistant bacteria, the other thrust of the membrane vesicle technology — the drug delivery system — is especially important.

Beveridge and his team have designed a new technology to introduce an antibiotic called Gentamicin into the membrane vesicles originally derived from the bacteria. Bacterial pathogens recognize the membrane vesicle as its own, and take it up. But little do these pathogens know that these vesicles contain gentamicin and enzymes that can degrade them. When the vesicles burst, the antibiotic and enzymes are released, killing the bacterium.

Interestingly, this technology is not unheard of in the natural existence of bacteria. As part of his basic research on these vesicles, Beveridge found that when a bacterium is under a low nutrient load, it can shed vesicles that will attack other bacteria and kill them. The enzymes in the vesicles can punch holes in the cell walls of other strains of bacteria and destroy them, liberating nutrients for the attackers.

Fighting antibiotic resistance

One way that bacteria can resist antibiotics is by altering their surface structure. This prevents the antibiotic from entering the bacterium. Also, some bacteria infect tissue cells and hide deep in the tissue where the antibiotics can't get to. Typical oral administration of antibiotics is not effective in combating these intracellular bacteria. The antibiotics reach the body fluids, but do not easily enter the cells of a tissue.

Using membrane vesicles, the antibiotics can be delivered to these hard-to-reach areas because the tissues can be fooled into taking up the vesicles. Bacteria that are resistant to antibiotics because of their altered membranes are also fooled by the vesicles, which can get through this 'barrier' that the antibiotics alone cannot.

The drug delivery system has a wide range of potential applications. For example, it is possible that antibiotics or other drugs can be delivered to specific tissues. If the bacterial infection is in the gut, then vesicles from a gut pathogen would be used to deliver the antibiotic that best treats that infection. This could also mean that fewer antibiotics would be necessary and there would be less selective pressure to makes pathogens antibiotic-resistant. One possibility could lie in using the vesicles to deliver anti-tumor drugs to malignant tissues.

Beveridge's team is now using infected tissue cultures in the lab to see if the antibiotics within the vesicles can destroy intracellular pathogenic bacteria. They are hopeful that the vaccine delivery system will be in use by the agricultural and medical industry in five to eight years, with the drug delivery system in use in about 10 years. Beveridge's research has also attracted a number of industry supporters and has patents pending. ■

Acknowledgements

This project is funded by the Canadian Bacterial Disease Network.

TERRY BEVERIDGE FROM *J.OF BACTERIOLOGY*, 181: 4278-4733.

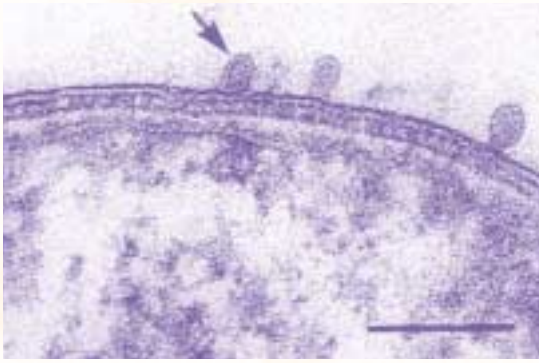


Fig. 2. A section of *Pseudomonas aeruginosa* showing the development of membrane vesicles before they are released from the host cell. The arrow is pointing to a membrane vesicle that has a visible membrane bilayer and periplasm. The bar represents 250 nm.

DAVID BARR

Fig. 3. Prof. Terry Beveridge, Dept. of Microbiology, University of Guelph, is making use of membrane vesicles in more effective vaccine and drug delivery systems.

Immune development GETS A BOOST from flax oil

Flaxseed is a versatile commodity. Livestock eat it in meal form as a protein supplement. Oil-based paints contain linseed oil, another name for flaxseed. And a growing number of people are buying flaxseed oil to stave off heart disease and improve skin health. Early results suggest an exciting new role for this Canadian crop.

Flaxseed oil already has the attention of the health-conscious public, who are well aware that heart-health risks can be diminished by consuming foods low in saturated fats and high in unsaturated fats. Now it appears possible that immune development, too, could be stimulated by consuming oils with specific characteristics.

In laboratory tests at the University of Guelph, the consumption of flaxseed by young animals improved the development of their immune systems. Nutritional scientist Prof. Bill Woodward found that the oil boosted immunity in weanling laboratory mice. The next step will involve testing the efficacy of flaxseed on the immune defenses of humans.

Making the link between the consumption of flaxseed oil and immune development would be a significant boon to Canadian farmers. As a crop, flax is well-adapted to Canadian conditions. Canada produces about 40 per cent of the world's 2.78 million tonnes of flaxseed. Its quality is held in high regard, due in part to its enviable oil content of 43 per cent. Developing flax to boost immune development would greatly add value to the crop.

For his research, Woodward looked at two types of unsaturated fatty acids in plants: n-3 and n-6. Commonly known as omega-3, the n-3 fatty acid recently gained attention for its role in reducing the incidence of heart disease and improving mental and visual functions in humans. (A pioneer and leader in the understanding of omega-3 is Woodward's colleague, Prof. Bruce Holub.)

Other studies have looked at specific oils from animal species such as fish, and found that they are loaded with heart-healthy n-3 fatty acids. But fish oil is expensive and also has anti-inflammatory properties that may not always be appropriate, and in some cases may actually cause a depressed immune response.

Woodward chose to test diets with six types of plant oils: safflower, corn, soybean, canola, flaxseed, and olive oil. Each has varying ratios of n-3 to n-6 fatty acids. Safflower and corn oil, for example, are very high in the n-6 fatty acids and low in n-3, while flaxseed oil shows the completely opposite composition (Fig. 1). His goal was to determine which ratio was optimal for creating a positive effect on immune response.

He chose to look at weanling mice because — as with all animals — the immune response is developing in the young, and mice are good subjects because they mature quickly. For the experiments, groups of 20 mice were fed diets supplemented with each of the six plant oils in various concentrations and proportions. The immune response of the mice was determined using a cell-mediated test and an antibody test. An increase in the level of blood antibodies produced by the animal was used to indicate the antibody-type of immune response. A functional index was also applied

CRYSTAL NORRIS
AND MIKE WEST

BILL WOODWARD

OIL SOURCE	FATTY ACID CONTENT (% BY WEIGHT)		
	oleic acid	linoleic acid (n-6)	a-linolenic acid (n-3)
Safflower	22.5	61.4	Not detected
Corn	33.3	48.0	0.4
Soybean	27.9	32.9	5.7
Canola	46.9	18.1	9.1
Flax	**23.8**	**13.8**	**43.5**
Olive	50.3	20.7	0.7

Fig. 1. Summary of fatty acid composition in the six plant oils used in Prof. Bill Woodward's study.

to assess the cell-mediated immune competence (Fig. 2).

Woodward's results consistently showed flaxseed oil had the most positive effect on the development of both types of immune response. As he nears the end of this three-year study, the researcher believes that the level of n-3 fatty acids in flax oil is partly responsible for the improved immune response, although an even more important feature may be a low level of n-6 fatty acid. Other oils — olive oil, canola oil, and soybean, in that order — fared well too. ■

Acknowledgements

Major funding for this project was provided by the Ontario Soybean Growers' Marketing Board and the Ontario Ministry of Agriculture, Food and Rural Affairs. Omega Nutrition Canada Inc. of Vancouver provided oil samples.

BILL WOODWARD

GROUP	CELL-MEDIATED RESPONSE (accumulation of moisture, %)	ANTIBODY RESPONSE (serum titre)
Zero-time	1.7^{A}	5.8^{A}
Safflower	6.4^{BC}	6.8^{B}
Corn	6.5^{BC}	6.5^{B}
Soybean	5.2^{B}	7.6^{C}
Canola	8.1^{CD}	7.6^{C}
Flax	**8.6^{D}**	**7.2^{C}**
Olive	8.0^{CD}	7.7^{C}

Within each column, mean values that do not share a letter are statistically different.

Fig. 2. Comparing the ability of six plant oils to promote the development of immune competence.

Counting the benefits of soy

Growers, processors, and consumers all win with isoflavone-rich soy foods

Isoflavones are naturally occurring plant chemicals found in soybeans. Their health benefits are thought to be many, including lowering cholesterol levels, inhibiting cancer cells, and preventing tumor growth. Researchers at the Guelph Centre for Functional Foods (GCFF) are taking a closer look at these benefits, as well as ways to increase yields and isoflavone levels in the fields.

RAKKA GAGLANI
AND SHERI GOULET

The health benefits of soybeans have long been known to Asian populations. Studies have shown that Asian men and women have lower rates of certain cancers than do their counterparts in the Western world. This is believed to be the result of their regular consumption of soy foods such as soy milk, tofu, miso, tempeh, and other forms of soybeans.

A range of studies that investigate the properties of this important cash crop is underway. Led by Dr. Chung-Ja Jackson of Laboratory Services' GCFF, a division of the University of Guelph, the team hopes to learn more about soy's health benefits and potential crop improvements.

Jackson and her group are currently collaborating with another team of researchers from the University of Toronto, headed by Dr. David Jenkins, on a clinical trial to assess whether consuming isoflavones can reduce cholesterol levels. Specifically, the study examines the pathway of isoflavones in the metabolism. The University of Toronto is conducting the clinical trials in which the participants consume soy food diets with varying isoflavone levels.

Cholesterol levels are measured before and after consumption of the special diet. Isoflavone levels in the soy food and in the urine of subjects are then analyzed at the GCFF using high performance liquid chromatography. The researchers will be able to determine the isoflavone levels in the food, how much is excreted in the urine or retained in the body, and how these factors relate to cholesterol levels.

DAN VATOUR

Fig. 1. Dr. Chung-Ja Jackson uses high performance liquid chromatography to measure isoflavone levels in different soybean varieties.

Other clinical studies have shown that isoflavones are active agents in the prevention of breast, colon and prostate cancer, arteriosclerosis and osteoporosis. To date, results from the clinical study are promising on the use of isoflavone-rich soy foods to lower cholesterol levels.

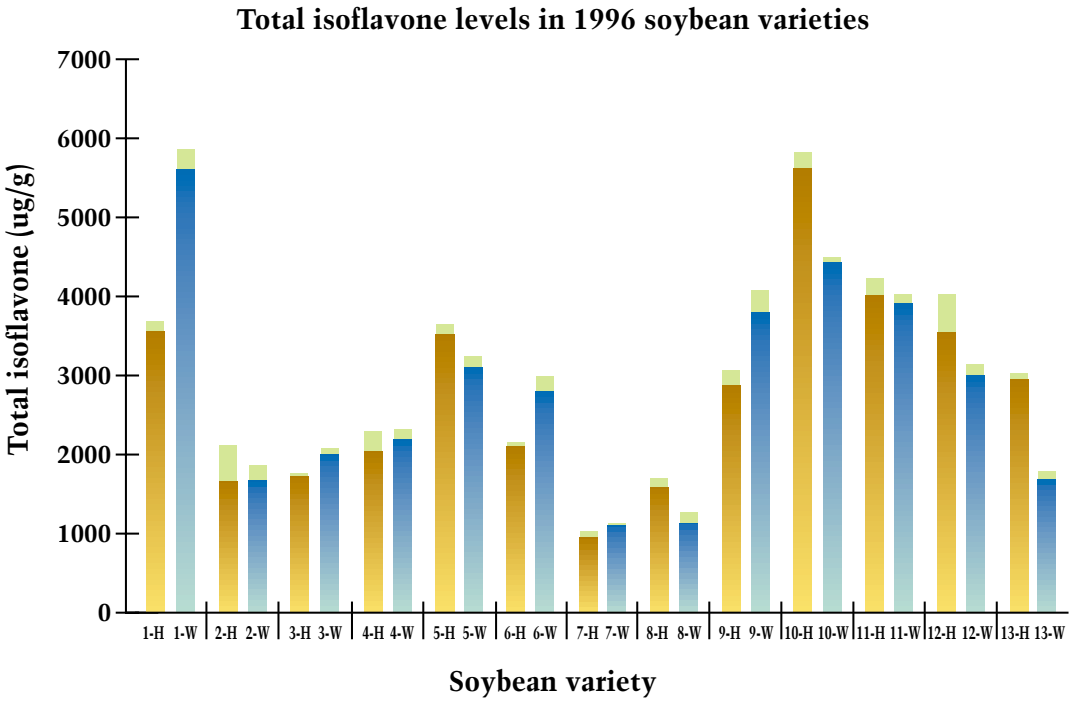


Fig. 2. Comparison of isoflavone levels in 13 varieties of soybeans in 1996 at two locations in Ontario.

Jackson and her team from the GCFF are also involved in a collaborative research project with the University of Western Ontario. This study uses *in vitro* tests to examine the effects of isoflavones on cancer cells and *in vivo* clinical trials using mice. The GCFF formulates the isoflavone mixtures — containing varying levels and types, or isomers, of isoflavone — used in the study. The mice are first treated with cancer cells and are then fed the isoflavone mixture in their diet. Pending their results, this research may progress in the future to the human level of clinical trials in cancer patients.

Yet another project involves collaborations with the University of Guelph's Department of Plant Agriculture and Ridgetown College, Agriculture and Agri-Food Canada (Harrow, Ontario), and the International Potash and Potassium Institute. These agronomy studies are examining a wide variety of topics. For example, researchers are looking at the use of different fertilizers to increase yields and isoflavone levels in soybean crops. Preliminary results have shown that soybean yields and isoflavone levels are positively related to the application of potassium to the soil. The group presented their data at the International Molecular Farming Conference last year.

It has also been found that the isoflavone content of soybeans will vary widely as a result of differences in soybean varieties, with the location of the crop and with environmental conditions, such as the weather during the growth year.

In Ontario, where soybeans are grown more extensively than any other crop — covering more than two million acres — all of these projects may prove to be very beneficial for consumers and producers. The research on soy foods containing isoflavones will give Ontario-grown soybeans added value and a competitive advantage in a market driven by increased health consciousness, globally. ■

Acknowledgements

The research on isoflavones and cholesterol is sponsored by the Natural Sciences and Engineering Research Council (NSERC) and the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA), as well as several food agencies. The KGK Synergize Company, London, Ontario, provided funding for the cancer studies, which was matched by the National Research Council's Industrial Research Assistance Program. The agronomy studies are sponsored by OMAFRA, the Ontario Soybean Growers' Marketing Board, NSERC, the International Potash and Potassium Institute, and numerous industry partners.

The Joy of Soy

The mainstream food market grows at about five per cent a year... but the soybean and natural food markets are booming with a 20 per cent annual growth. Last October, the U.S. Food and Drug Administration announced soy product manufacturers are permitted to make health claims on their labels. The claim states that the consumption of 25 grams of soy protein per day (6.25 g per serving) may reduce the risk of heart disease. As interest in these products grows — and if Canada follows the FDA's recommendation and permits the health claim labelling — Ontario soybean farmers will be well-positioned to benefit from an increased demand for their product.

Public Research → Commercial Technology

Growing the Ontario Agri-Food Industry

Norgen Biotek

Serving the biotech community with research support services

Fig. 1. Norgen Biotek headquarters in St. Catharines.

The competition to develop vaccines, improve diagnostics, and advance gene therapeutics has never been fiercer. Increasingly, companies are seeking out private labs such as Norgen Biotek Corporation in St. Catharines for expert, customized and confidential services.

With deep roots in Brock University and a wide network of specialists, the scientists and technicians at Norgen Biotek offer expertise in biology, virology and immunology. The Canadian start-up company provides custom services and reagent kits dealing with molecular biology and biotechnology. Its services include but are not limited to custom gene construction, large-scale project DNA sequencing, gene expression, and viral diagnostics.

Dr. Yousef Haj-Ahmad, a professor of biology and genetics at Brock, founded Norgen several years ago. The molecular biologist-virologist by training was instrumental in the development of the first human adenovirus vector system while at McMaster. Norgen is not his first private venture: In 1986, he co-founded Procyon Biopharma Inc. in London. Haj-Ahmad is also affiliated with the University of Guelph through a cross-appointment to the Department of Pathobiology.

Fig. 2. Loading the automated DNA sequencer.

About 50 per cent of Norgen Biotek's staff members are former or current students of Brock University, where the company sponsors research students in biology/biotechnology and provides industrial research scholarships.

Norgen is in the process of developing a line of reagent kits to meet the needs of researchers in molecular biology in both academic and commercial sectors. Using state-of-the-art equipment, Norgen scientists are working to develop proprietary DNA isolation and transfection kits, as well as a number of mammalian cell lines suitable for molecular biological research.

A variety of adenoviral laboratory services are available at Norgen, ranging from adenovirus vector engineering to viral amplification and titration. Diagnostics are also a key part of Norgen's work, and include the detection of swine influenza virus (SIV), and porcine reproductive and respiratory virus (PRRSV), as well as the development of a PCR-based diagnostic test for bovine leukosis virus (BLV).

Commonly used viral detection assays (such as AGID or ELISA) rely on the immune response of the host, more specifically a buildup of antibodies to viral proteins. Sufficient accumulation for detection of these antigens may take over four to six weeks post-infection. During this lag time, conventional assays will give a false-negative result, as an infected animal may test seronegative for antibodies against the virus.

A PCR-based assay, in comparison, will detect the presence of viral DNA very shortly after infection.

Swine Influenza Virus

Influenza viruses infect a variety of species, including humans, pigs and birds. While influenza viruses do not pass readily between humans and birds, viral transmission between humans and other animals is well documented. Evidence suggests that genetic reassortment of human and avian viruses may occur in an intermediate animal, such as swine, to produce new and potentially more virulent influenza strains. At Norgen, early detection by PCR helps farmers to establish effective vaccination programs and prevent large-scale infections.

Fig. 3. Amplifying and purifying plasmid/genomic DNA.

Fig. 5. Generating recombinant adenovirus.

Porcine Reproductive and Respiratory Syndrome Virus

Commonly known as PRRSV, this virus is considered to be the most expensive disease to threaten the swine industry. In both Canada and the United States, records show financial losses of up to 70 per cent in total profits from performance losses alone. Furthermore, the high rate of mutation of the virus means that current vaccines quickly become ineffective. Norgen's PCR-based method allows for the early detection of new strains, and aids researchers in their efforts to produce more effective vaccines.

Bovine Leukosis Virus – a PCR-based diagnostic test

Enzootic leukosis is the most common neoplastic disease of cattle, and is caused by BLV. BLV is a retrovirus that is closely related to the human T-cell leukemia viruses, and is spread through direct transfer of infected cells between animals. A BLV-infected herd suffers direct economic losses due to tumors on animals and indirect losses due to restrictions on the sale of infected animals/germplasma to foreign markets. BLV infection may spread unabated in an apparently healthy herd as infected animals may never display overt clinical symptoms.

In addition to eliminating potentially disastrous false negatives, Norgen's PCR-based method shows signs of higher sensitivity as well as greater accuracy than the standard AGID or ELISA tests.

Norgen DNA Isolation Kit

The quality of DNA used in scientific and medical research is a critical factor in the success of subsequent applications. Traditional methods of isolating pure DNA have typically involved toxic chemicals (phenol/chloroform extraction procedures) and very long centrifugation times (cesium chloride banding procedures). Not only are such procedures slow and costly, they also risk the health of laboratory staff and require the disposal of hazardous waste chemicals. Phenol can cause severe chemical burns while chloroform is a toxic, flammable and very volatile compound.

A number of the currently used kits suffer from disadvantages ranging from high price to failing to produce the desired quality and yield. Furthermore, none of these kits is produced in Canada. Norgen Biotek is developing a proprietary DNA isolation kit that is comparable to commercially available kits in terms of yield and purity with the advantage of minimizing the use of hazardous chemicals. ■

For more information
Tel: (905) 227-8848
www.norgenbiotek.com

Acknowledgements
In addition to private investors, Norgen Biotek Corp. receives funding from the Ontario Ministry of Agriculture, Food and Rural Affairs, the National Research Council through its Industrial Research Assistance Program, and the Natural Sciences and Engineering Research Council via the Industrial Research Fellowship.

Fig. 4. Developing new mammalian cell lines.

Some Common Acronyms in Diagnostic Testing

AGID = Agar gel immunodiffusion

ELISA = Enzyme-linked immunosorbent assay

IFA = Indirect fluorescent antibody

PCR = Polymerase chain reaction

Canadian Research Institute for Food SAFETY

CHERYL RAE AND MICHELLE OSBORNE

CRIFS is 'command central' for food safety research

Outbreaks of illness from foods contaminated with harmful bacteria such as *E. coli* have consumers apprehensive about some items on their plate. Food-borne pathogens caused an estimated two million Canadians to fall sick in 1998, representing a $3- to $5-billion economic drain through medical costs and loss in productivity. To combat this problem, the Canadian Research Institute for Food Safety, or CRIFS, has been established as a place where diverse studies in food safety converge.

CRIFS, which came together at the University of Guelph in June 1999, is working to decrease the costs of food-borne illnesses to society. It fosters collaborative research among food safety disciplines and policy implementers. Under its wide umbrella, there are more than 100 scientists and graduate students involved in various microbial food-safety research projects, making CRIFS the largest institute of its kind in North America.

Through studies in diverse disciplines such as microbial physiology, food safety engineering, food diagnostics, epidemiology, pathogenesis, and microbial ecology, CRIFS is casting a wide net to assist all sectors of the agri-food industry. CRIFS will provide research and development as well as knowledge transfer, according to Prof. Mansel Griffiths, Director of CRIFS who is also with the Department of Food Science at Guelph.

CRIFS has received $8-million in funding from the Canada Foundation for Innovation and numerous industry supporters. That funding is being used to provide researchers with the latest equipment and facilities for state-of-the-art research leading to improved food safety.

Food Policy Centre

Food safety policy is the focus of an associated institute, the prospective Food Policy Centre, also to be located at the University of Guelph. Plant Agriculture Prof. Doug Powell, who will lead the centre, notes that research conducted by CRIFS has already led to the recognition of fresh fruits and vegetables as potential vehicles of food-borne illness. These findings, when related to policy makers, resulted in on-farm

food safety plans for the individual producers within the Ontario Greenhouse Vegetable Growers' Association and the Ontario Vegetable Growers' Marketing Board. Similar programs such Hazard Analysis Critical Control Points, better known as HACCP, have been developed for producers in the province and across the country.

Level-three lab facilitates comprehensive studies

Griffiths hopes to expand CRIFS further, to involve faculty from other universities. The institute will also be working in close partnership with Health Canada, Agriculture and Agri-Food Canada, and a number of top-ranking scientists from across the country. Its on-campus locale is being renovated and will include a level-three containment facility, as well as advanced instrumentation and processing equipment such as a confocal laser scanning microscope, a gene sequencer, and a gene fragment analyzer.

This technology can be used in many ways. The *E. coli* bacteria is one example. The microorganism, which causes the well-known 'hamburger disease,' may trigger serious and potentially life-threatening illness by producing a toxin that breaks down the lining of the intestine and damages the kidneys. What makes the pathogen so dangerous is that foods contaminated with *E. coli* bacteria do not look or smell spoiled. Researchers have developed a bioluminescent strain of *E. coli* O157:H7 by inserting the gene from a firefly that is responsible for a glow-in-the-dark trait, into the pathogen's DNA. This technology allows for the monitoring of the pathogen's mortality during sausage production.

The level-three lab, which requires increased security measures such as showering before and after entering the facility, will allow for a more comprehensive study of pathogenic organisms posing unknown risks.

Along with Health Canada and the University of Guelph's Laboratory Services division, CRIFS labs are developing detection methods for the O157:H7 bacteria. Other CRIFS researchers are attempting to identify factors that make the microorganism a human pathogen as well as behavioural characteristics of the organism in fermented sausage, and to develop models that describe its survival. So far, results indicate that the best *E. coli* survival rates occur in the regions of the sausage where more fat is located.

The general aim is to design preservation systems that maximize the stress imposed on these organisms and decrease their ability to survive.

Powell believes CRIFS demonstrates pro-active management of food safety risks, from basic research through to on-farm implementation. The institute should lead the way for similar programs that aim to further reduce the risk of food-borne illnesses and enhance the safety of the Canadian food supply.

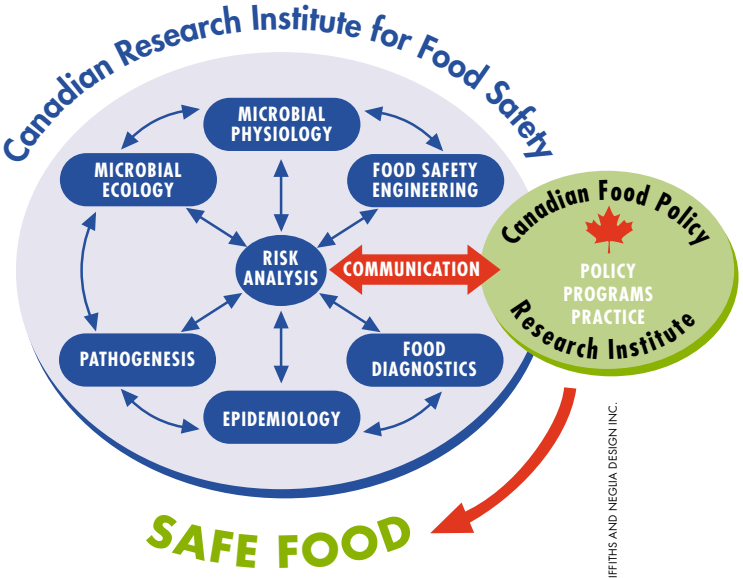


Fig. 1. Integration of CRIFS research.

Policies that ensure safer foods will help Canadian products remain competitive on the global markets — and that's significant for the Canadian economy, which relies heavily on international trade. Enhancing the safety of Canada's food supply will improve the marketability of domestic and exported foods and protect the health of Canadian and foreign consumers. ■

Acknowledgements

CRIFS has received funding from the Canada Foundation for Innovation.

a fiLm no one wants to see

tracking biofilms in the food industry

BLYTHE MCKAY
AND NIKI STRANG

Biofilms are protective layers that form around colonies of bacteria attached to a surface. The films make the bacteria resistant to sanitization methods, cleaning agents, and antibiotics. Help is on the way through faster and more accurate methods for detecting and eliminating biofilms and the bacteria they protect.

Fig. 1a. Scanning Electron Microscopy (SEM) of *Pseudomonas putida*.

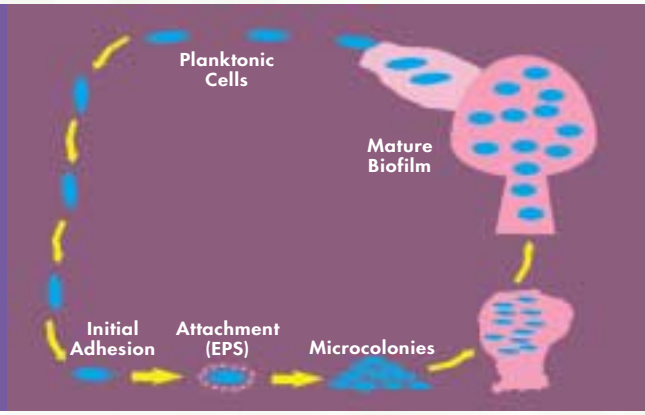


Fig. 2. The stages of biofilm development. MIN SEOK CHAE

Biofilms are slimy layers formed by secretions from microscopic colonies of bacteria. They can be found in food and on non-food surfaces such as dental plaque and the slime layer found on rocks in streams or in pipelines. Prof. Heidi Schraft of the Department of Food Science at Guelph is focusing on detecting them in food. Identifying biofilms in the food processing environment is the first step towards developing better sanitization procedures and regimes.

Through a recent award from the Canada Foundation for Innovation's New Opportunities Fund — which provides infrastructure support to young faculty — Schraft, along with two other recipients, Food Science Prof. Yoshinori Mine and Pathobiology Prof. Dongwan Yoo, have purchased equipment for molecular biology and imaging. An epifluorescence microscope and a cooled-charge coupled-device camera with image analysis software are part of the new acquisitions.

The study of biofilms in the food industry is altogether new for microbiology. In the medical field, however, research and information about biofilms have been around for quite some time.

Schraft's long-term research involves three food-borne, pathogenic microorganisms — *Listeria, Campylobacter* and *E. coli*. *Campylobacter* is a bacterium that is frequently found on raw poultry products. It can cause food poisoning in humans that eat undercooked poultry, with symptoms such as fever and diarrhea.

Schraft is trying to determine if these specific bacteria will form biofilms on solid surfaces, and if they do, whether this will enhance their survival in the food processing environment. She is also exploring whether certain groups of bacteria are better at forming biofilms than others.

She believes bacteria that easily produce biofilms may have an increased chance of survival and of causing disease, compared to bacteria that do not form biofilms or those that form them with difficulty. According to Schraft, the presence of biofilms in food processing equipment may have been the source of various health problems in the past that were linked to food-borne pathogens. With the help of new technology and research, more evidence is being gathered to back up this theory.

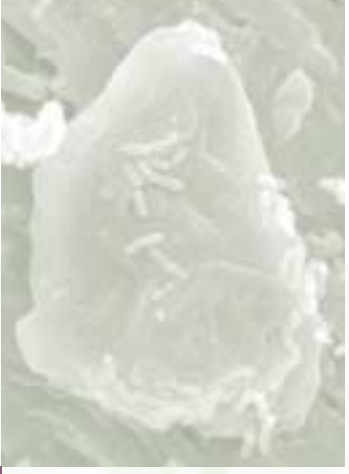


Fig. 1b. SEM of *Pseudomonas putida*.

Another aspect of the research involves discovering ways to get rid of biofilms, with hopes of eliminating them from the food processing environment where they form in areas such as gaskets used in metal pipelines. Biofilms are composed of exo-polymeric substances (EPS's) — bacteria byproducts such as carbohydrates and proteins — that are able to bind water more easily and as a result create the slimy layers.

Determining the composition of these polymeric substances is first on the agenda. Once this is known, it may be possible to develop enzymes that will digest away the biofilm. Schraft says that other possible methods for eliminating biofilms might include running a light electric current through them to loosen the EPS's, or to physically or chemically change the surfaces that the bacteria fasten to, so they will no longer be able to stick.

Schraft is collaborating with researchers from other disciplines such as physics and chemistry, and it is apparent that biofilm research is not confined to microbiology alone. For example, she recently began collaborating with Prof. Jacek Lipkowski, an electrochemist in the Department of Chemistry and Biochemistry at the University of Guelph. Lipkowski's research involves the use of techniques that help to determine how charges on bacteria and surfaces may influence the initial bacterial attachment to a surface.

Biofilms are not easy to detect, nor are they easy to grow artificially in the laboratory. Previous methods involved the laborious process of counting bacteria under the microscope. Using the new equipment will be more efficient and human error will be reduced. It provides accurate images and sizes of the cells, while human observation is subjective.

KIRSH KAHAR

Prof. Heidi Schraft, Dept. of Food Science, University of Guelph.

Similar to a digital camera, the charge-coupled device camera takes digital pictures of the bacteria as seen under the microscope. These pictures are then received by the new computer, which allows the images to be counted automatically and viewed on the computer screen.

While performing much of the testing and lab work, Food Science graduate students are conducting related research. One study focuses on lactic acid bacteria, which although non-pathogenic, are thought to form biofilms in beer tanks and pipelines leading to the spoilage of beer. *Campylobacter* and *Listeria monocytogenes*, a food-borne pathogen that can cause meningitis and abortions in humans, are also being researched. ■

Acknowledgements

Schraft's research is sponsored by the Natural Sciences and Engineering Research Council, the Ontario Ministry of Agriculture, Food and Rural Affairs' Food Research program, and the Ontario Cattlemen's Association.

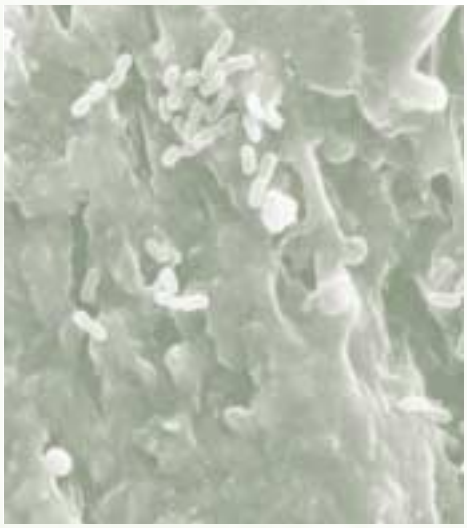


Fig. 1c. *Pseudomonas putida* attached to a rubber gasket commonly used in milk pipelines.

MARTIN SCHWALBE

Fig. 3. Graduate student Nan Tang and her supervisor, Prof. Heidi Schraft, discuss the testing of a poultry sample.

a short take on biofilms

Biofilms have been associated with *Salmonella* poisoning, Legionnaires disease, and with outbreaks of cholera, where the bacteria are protected from the chlorine-treated water. They are also a concern in medical circles because they form on materials inserted in the human body such as pacemakers, contact lenses and artificial joints, and can lead to infection and the body's rejection of the implanted substance. In dentistry, the formation of plaque and the development of cavities can be attributed to biofilms.

Water systems are affected by the buildup of biofilms — more commonly referred to as slime — which can result in plugged drains. In the food industry biofilms are found on the surfaces of food and beverage processing and packaging equipment and transmit pathogens such as *E. coli*.

Researching the LABELLING QUESTION

Some consumers believe that foods produced through crop biotechnology should be labelled. There is no question that consumers are entitled to choice in their purchasing decisions. But in researching the ways to best provide that choice, it is quickly apparent that labelling is complex and costly, and in this case, would not be particularly informative. The real questions are: Just what would we label, at what cost, and who would pay?

GORD SURGEONER
President, Ontario Agri-Food Technologies

Virtually all foods we eat today have been genetically modified. Today's corn, strawberries, apples, chickens, cattle etc. bear little resemblance to their wild ancestors, and most of these crop and animal varieties did not exist in nature. All we have to do is look to dogs where neither Great Danes nor Chihuahuas exist naturally. Farmers, seed growers and breeders, even home gardeners, have always selected for traits that enhance productivity, disease and insect resistance, taste and colour. The list could go on.

These improvements have been achieved by selecting for traits (genes). What is new is the ability through modern science to move genes between species. This ability is based on over 100 years of discovery from Gregor Mendel, an Austrian monk who demonstrated inheritance rules in peas, to the identification of DNA by James Watson and Francis Crick in 1955. To some extent, this process mimics what occurs in nature, where common bacteria regularly exchange genetic information between species.

The process of modifying genetic material to improve foods must be subject to strict regulatory overview. It is. In Canada, Health Canada and the Canadian Food Inspection Agency (CFIA) share responsibility for ensuring that all foods entering the marketplace, including foods produced through biotechnology, are safe for Canadians to eat. Both agencies post decision documents related to biotech foods on their websites, **www.hc-sc-.gc.ca** and **www.cfia-acis.agr.ca** respectively. The first of these products was approved in 1994. Health Canada has responsibility for food safety whereas CFIA has responsibility for livestock feeds.

Just what would we label?

The first question with labelling is what to label. Let's walk through a fast-food restaurant and see how labelling might apply. Chicken and beef burgers are popular items. Like people, chickens and cows are vaccinated regularly using recombinant DNA (genetically modified material) to prevent disease. This greatly reduces the need for antibiotics but raises the question whether the beef and chicken products should be labelled as genetically modified. In all likelihood, these animals were fed corn and soybeans, crops that increasingly are produced through the tools of biotechnology. Although the meat contains no evidence of a genetic change, should it be labelled?

Those burgers are all in buns and most people like to add toppings. Using biotechnology, we can take a gene from winter wheat and add it to spring wheat to increase the protein content of the flour, a process that would otherwise require years of plant breeding. Should this require a label? Should the tomato that contains a reverse copy of one of its own genes that acts to slow the ripening process be labelled? It has certainly been modified.

As we continue through the restaurant, we will almost certainly see canola oil, the favorite cooking oil for french fries because of its unsaturated fatty acid profile and great

taste. Currently about 65 per cent of the Canadian canola crop is produced through biotechnology, although the resulting oil contains no trace of the genetic change. Should it be labelled? Finally there's the syrup for your cola. Most soft drinks use fructose, derived from corn, as a sweetener. About one-third of the corn grown in Canada and the United States is produced through biotechnology. Should soft drinks be labelled even though we can't detect any change in the fructose?

At what level and at what cost?

By now I hope it is clear how complex the issue of labelling is. But we've only just begun. The next question is what level of sensitivity is acceptable in determining the presence of modified material. If the answer is zero, it is important to point out that zero is really a relative measure of detection sensitivity. For example, a sample tested at a level of sensitivity of one part per million might show zero presence of modified material, at one part per billion it might show 100 parts per billion. At one part per trillion, it might show 100,000 parts per trillion. The sample doesn't change, just the level of sensitivity in testing it. In the European Union, they are indicating that one per cent of a crop can be modified without requiring a label. In Japan, labels will not be required unless the genetic change can be detected.

Finally, consumers should realize that labelling has costs. They include the cost to the grower of keeping biotech and non-biotech crops separate, the cost of transporting, processing and packaging these foods separately and the costs of testing and monitoring for compliance at every step from the field to your table. A recent study in Australia showed that it would cost an additional three to six per cent, and over $3 billion (Australian) to industry alone in the first year, if all foods were labelled. Importantly, there are typically about 60,000 choices currently in a large supermarket. Can we realistically double that offering to provide both biotech and non-biotech choices? Our food supply exists within a global marketplace, with some 5,000 food shipments entering Canada each day. Should we test all of these products, and who should pay?

In Canada, the Canadian Council of Grocery Distributors, representing grocery retailers, and the Canadian General Standards Board have launched a project to develop a national standard for voluntary labelling of foods produced through biotechnology to ensure a consistent and credible approach across the country. The Consumers' Association of Canada is the co-chair of this project. This is the same process that resulted in a national standard for identifying organic foods. Once the standard is in place, voluntary labels can provide consumers who really want it with a choice to either buy or avoid foods containing genetically modified ingredients. In fact, companies are currently free to label foods in this regard as long as the label is not false or misleading. Some 60 organizations have been asked to participate in this process. I am confident it will answer some of the questions raised here.

Ultimately, it is important for Canadians to remember that we have a food regulatory system that ranks with the best in the world and is emulated by many. Each product is assessed on a case-by-case basis, using the best available safety and risk assessment procedures. The tests are similar to those used to evaluate pharmaceutical products. Published research has shown that they are so rigorous that many so-called natural food ingredients would actually fail to comply. The rigour of the system is evidenced by the fact that there has not been a single example of illness or harm to humans or livestock from any of these crops approved in Canada.

As part of the regulatory process, every product, no matter how it is grown or processed, must be labelled if there is a health or safety issue such as allergenicity or a change in nutritional value. This system works and Canadians have every reason to be confident in it and in the food we eat. I believe there is no reason to change it, but I also believe those who want a choice should have it. We are working towards a voluntary system for meaningful labels that can be monitored to ensure truthfulness and which will provide Canadians with that option. ■

For more information

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www.oaft.org

statement by scientists

in support of the responsible development and application of biotechnology

The following open letter appeared in the editorial pages of the National Post *newspaper on November 1, 1999.*

It was signed by more than 120 Canadian scientists.

As scientists involved with the research and development of biotechnology and supporters of its use to provide better health and nutrition to people around the world, we urge Canadians to participate in a dialogue about the technology's potential. We strongly encourage Canadians to base that dialogue on sound science, on facts and on the results of peer-reviewed research. We hope that Canadians will not be influenced by those who resort to unfounded speculation and discredited science to alarm them about the safety of the foods they eat, the system that regulates those foods or the potential of new technologies to improve and expand the food supply.

Scientific knowledge continues to grow at a rapid rate. The advances in genetics over the last 20 years are remarkable and impressive. As working scientists, who have devoted our careers to participating in and learning from these developments, we believe the understanding of the process of genetic modification is sufficient to be confident about its outcomes. In fact, the transfer of genes between species and the creation of new drugs and plant varieties by genetic enhancement have been part of medical and agricultural improvements for at least a decade with no proven negative effects on people. Of course, we are constantly reviewing and assessing new scientific information.

We understand that those who have not kept abreast of these advances might find the sheer volume of new knowledge daunting. However, we expect anyone who chooses to communicate to Canadians about science will do so responsibly using facts and the best available information, rather than unsubstantiated allegations and rhetoric as their platform.

We believe that Canada has a regulatory system for the assessment and approval of all foods and drugs marketed in this country that ranks with the very best in the world. Health Canada demands that extensive data be submitted on the detailed chemical and biochemical composition of crops and drugs produced through biotechnology. When a genetic enhancement produces new plants resistant to insects and diseases, all of the altered plant proteins and other constituents, including secondary metabolites, are analyzed for toxicological effects. This includes animal feeding trials. These tests are similar to those used to evaluate pharmaceutical products. Published research shows that these tests for safety are so rigorous that many natural food ingredients would actually fail to comply.

It is important for Canadians to understand that food biotechnology uses the same tool that has provided more than 100 medical products, including insulin, hepatitis vaccine and products for counteracting cardio-vascular disease. It has the potential for equally impressive results in crops. For example, in developing countries, at least 400-million women of childbearing age suffer from anemia as a result of iron deficiency. This can lead to physical and mental retardation, premature births and natal mortality. About 2-million children die each year as a result of vitamin A deficiency. These illnesses could potentially be eradicated thanks to a new variety of genetically improved rice that dramatically enhances the dietary supply of vitamin A and iron.

We believe that biotechnology will be needed to help us meet an even greater challenge. By the year 2035 the world's population is expected to grow to at least 8 billion. To feed that population, agricultural yield will have to at least triple. It is widely acknowledged that conventional growing techniques are not adequate to meet the need for self-sufficiency, food security or environmental sustainability.

To quote Gordon Conway, president of the Rockefeller Foundation, an organization whose mandate is to enrich and sustain the lives and livelihoods of the poor throughout the world, "The tools of biotechnology are going to be essential if crop-yield ceilings are to be raised, the environment preserved through reduction of pesticide use, the nutrient value of basic foods increased and farmers on less-favoured lands provided with varieties better able to tolerate drought and lack of soil nutrients."

We agree wholeheartedly. We cannot afford to let this potential be put at risk through misinformation or fear disseminated by those with other agendas.

We would like to take this opportunity to announce that today we have formed a national coalition of scientists who support the development of the tools of biotechnology to improve and enhance the quality and quantity of our food supply, based on the best available scientific knowledge. We invite responsible scientists from across the country to join with us in standing up for this important technology and for the integrity of the system that regulates it. ■

Les recherches en bref

Réponse aux besoins d'une population croissante en matière d'alimentation

Des aliments pour le futur

Une production alimentaire efficace est la priorité du nouveau centre de biotechnologie alimentaire

Le besoin d'une production alimentaire efficace ayant une incidence limitée sur la terre et les ressources augmente au rythme de la population du Canada. Le nouveau Food Systems Biotechnology Centre de l'Université de Guelph a été créé dans le but d'élaborer de nouveaux produits animaux et végétaux à valeur ajoutée et des systèmes alimentaires connexes qui permettront de répondre aux besoins technologiques des producteurs et aux exigences du pays en matière de terres.

La recherche contribuera à réaliser l'énorme potentiel économique de la biotechnologie et ainsi à assurer la prospérité de l'Ontario et du Canada. Le FSBC aidera également les chercheurs à créer des liens avec le secteur privé, ce qui favorisera un plus grand financement de la part des secteurs privé et public.

Une partie des recherches sur les plantes transgéniques porte sur la production de luzerne qui contient des antigènes offrant une immunité contre les infections virales chez le bétail. Dans le domaine moléculaire, les chercheurs sont en train d'élaborer de nouvelles techniques pour l'analyse de l'ADN et l'analyse protéique. Ils travaillent également en étroite collaboration avec les Services de laboratoire pour appliquer les nouvelles techniques à la commercialisation et créer des outils moléculaires qui permettront d'évaluer la sécurité alimentaire.

Le professeur Alan Wildeman est le directeur du FSBC.

La philosophie et la science unissent leurs efforts au FSBC

Bon nombre de questions morales se posent lorsque d'autres formes de vie sont utilisées pour répondre aux besoins des humains. L'éthique revêt de l'importance pour la science étant donné que celle-ci a pour but d'améliorer les conditions de vie, ce qui donne inévitablement lieu à des choix mettant en cause des jugements de valeur et des priorités.

Au mois d'août, un éthicien sera embauché à l'Université de Guelph à titre de personne ressource pour les chercheurs dans le domaine de la biotechnologie. Il sera membre du corps enseignant du département de philosophie et travaillera en collaboration avec le nouveau Food Systems Biotechnology Centre.

Selon le professeur Alan Wildeman, directeur de ce centre, l'éthicien aidera la communauté universitaire à rester au fait des attitudes du public et sera chargé d'informer le plublic et les sientifiques sur le débat relatif à la biotechnologie. Voici certaines des questions sur lesquelles l'éthicien se penchera : la privatisation du financement de la recherche avec retombées économiques pour l'université; l'intégration de la science et des préoccupations publiques dans une politique régissant la biotechnologie; le niveau de risque que le public est prêt à accepter; et les types de projets qui devraient avoir priorité en termes d'avantages collectifs et de valeurs.

Chefs de file dans le domaine du bétail domestique

Le nouveau laboratoire Genome Manipulation Laboratory aidera l'industrie canadienne du bétail à maintenir son rôle de chef de file dans le domaine des animaux et de l'agriculture

Pour répondre aux demandes croissantes et changeantes de la génétique du bétail au Canada, le Genome Manipulation Laboratory (GML) a été créé. Cette installation de recherche en génétique supérieure de l'Université de Guelph accélérera le développement de lignées améliorées de bétail domestique.

Le GML devrait être fonctionnel en septembre et on s'attend qu'il développe des reproducteurs élites transgéniques destinés aux éleveurs de bétail. L'EnviroPig constitue une étape très importante dans le développement de l'industrie du porc vivant. Le fumier de ce porc modifié génétiquement contient beaucoup moins de phosphore. De haut niveaux de phosphore dans le fumier peuvent avoir des effets dommageables sur la qualité de l'eau.

Au nombre des projets qui profiteront également du laboratoire GML, mentionnons la modification de poulets pour obtenir de nouveaux produits à partir de leurs oeufs, et le clonage de vaches laitières à forte production de lait.

Des gènes aux protéines

L'équipement et l'expertise font équipe pour obtenir des résultats

Une meilleure compréhension du lien qui existe entre les gènes et les protéines ainsi que de la façon dont les gènes déterminent la structure d'un organisme, permettrait de mieux comprendre comment un organisme fonctionne. Afin de faire appel à l'expertise de l'ensemble du campus, l'Université de Guelph a lancé le projet Des gènes aux protéines (Genes to Proteins). Dirigé par le professeur David Evans, le projet réunit 17 facultés regroupées dans six départements. Cette collaboration devrait contribuer à élargir le potentiel d'apprentissage pour la recherche en génétique et à augmenter le nombre d'applications des résultats.

De l'équipement avant-gardiste fera partie intégrante du projet, y compris une machine Biacore, un appareil permettant de créer des jeux ordonnés de micro-échantillons et un lecteur de puces, des ordinateurs pour la modélisation génétique, et un système de mise à jour des séquences de l'ADN existantes.

La recherche en génétique explorera des façons plus rapides de détecter des virus pathogènes dans les plantes et les animaux, d'améliorer le bétail en comprenant mieux la localisation et l'identité des gènes, et d'améliorer les plantes au moyen d'une sélection de caractéristiques telles qu'une tolérance accrue au froid, aux métaux toxiques ou à la sécheresse.

Hedley Technologies Inc.

Une compagnie de sciences biologiques à la recherche d'une solution de rechange naturelle aux pesticides

La perte de grains entreposés en raison d'insectes constitue un problème frustrant partout dans le monde. Pourtant, la protection de produits alimentaires entreposés contre les animaux nuisibles représente tout un défi, étant donné que cette étape est très proche du produit alimentaire final. La compagnie Hedley Technologies de Mississauga a trouvé une solution sans risques, à savoir la terre à diatomées. Cette substance poudreuse est un agent biologique naturel qui absorbe la couche de cire extérieure qui recouvre le cuticule de l'insecte. Éventuellement, l'insecte se déshydrate et meurt. Le produit Protect-It est maintenant utilisé dans plusieurs lieux d'entreposage et de transport, et est appliqué directement sur les grains et les semences. Le Pakistan et la Chine, où les pertes peuvent atteindre 30 pour cent, représentent d'énormes marchés potentiels .

Hedley continue ses recherches sur les insecticides à faible toxicité destinés à l'agriculture. Elle a élaboté deux nouveaux insecticides à utilisations multiples pour venir à bout d'une variété d'insectes. Elle espère créer un jour un insecticide entièrement naturel dont l'efficacité sera égale ou supérieure à celle des insecticides traditionnels et qui pourra être utilisé tant dans l'agriculture organique que conventionnelle.

Plantes transgéniques

Agricultural Plant Biotechnology Centre

La collaboration pour favoriser les innovations

La commercialisation des produits agro-alimentaires dans les marchés internationaux sera plus efficace grâce à la contribution de la recherche en matière de biotechnologie végétale à l'Université de Guelph. La recherche au nouveau Agricultural Plant Biotechnology Centre se concentrera essentiellement sur son objectif à long terme : l'élaboration de méthodes innovatrices et l'application de ces dernières à la productivité et à l'utilité des cultures.

Le centre comprendra plusieurs laboratoires et effectuera des recherche dans les domaines des aspects cellulaires et moléculaires de la résistance aux ravageurs, de la tolérance au stress, de l'amélioration de la photosynthèse et du potentiel de rendement de différentes cultures. Du nouveau matériel scientifique sera acheté et des modifications majeures au pavillon de phytotechnie sont prévues, y compris l'ajout de cinq étages.

Un projet est présentement en cours concernant l'étude des moisissures du genre Fusarium qui s'attaquent à l'épi du maïs. Dirigé par le professeur Peter Pauls, également directeur du nouveau centre, le projet utilise la transformation végétale (introduction de nouveaux gènes) et les marqueurs moléculaires (pour la sélection de la résistance naturelle) pour accroître la résistance aux moisissures du genre Fusarium et réduire la teneur en toxines du maïs.

Au nombre des autres projets, mentionnons la mise au point d'un gazon résistant à la sécheresse, la production de vaccins oraux à l'aide de plantes et le développement de techniques sanitaires comestibles pour des applications humaines et vétérinaires.

Du maïs qui tolère le froid

Les marqueurs moléculaires permettrent de connaître l'emplacement des traits du maïs

Mme Elizabeth Lee, professeur à l'Université de Guelph, utilise les marqueurs moléculaires pour accélérer la création de variétés de maïs plus fortes et tolérantes au froid. La technique des marqueurs moléculaires accélère le taux et l'efficacité de la sélection, étant donné qu'après avoir identifié les gènes qui présentent un intérêt, on peut en vérifier la teneur dans des plantes expérimentales sans attendre une pleine croissance.

Mme Lee cherche à identifier les régions chromosomiques qui sont responsables de la tolérance au froid chez ces hybrides de sorte qu'un plus grand nombre de lignées consanguines puissent être créées pour les courtes saisons de croissance populaires chez les producteurs de maïs de l'Ontario. Une connaissance précise des gènes à l'origine de la tolérance au froid peut être utilisée pour choisir les plantes-mères qui permettront de sélectionner des lignées tolérantes au froid sans avoir à recourir à la transgénèse.

Transformation rapide des plantes

Modification génétique plus rapide des plantes

À l'aide des méthodes classiques, la production de la première génération de plantes transgéniques peut prendre jusqu'à un an. À l'heure actuelle, deux générations peuvent être produites en un an grâce à une nouvelle technique élaborée par le professeur Massimo Sanago de l'Université de Guelph.

Le nouveau protocole est plus rapide et présente un taux d'efficacité de 10 à 30 pour cent dans le cas des pois, de cinq à 10 pour cent dans le cas du soja, et de 35 à 50 pour cent dans le cas de la luzerne. De plus, tandis que les méthodes classiques sont limitées à un petit nombre de variétés à l'intérieur de chaque espèce végétale, la nouvelle méthode peut également servir à transformer bon nombre de variétés de soja, de pois et de luzerne.

La nouvelle méthode utilise l'hypocotyle, cette partie de la plante qui se trouve entre les cotylédons et la racine. Une demande de brevet a été déposée.

Protéger les tomates du froid

Un produit plus savoureux et plus ferme pour le marché du frais et les industries transformatrices

Les industries transformatrices de l'Ontario doivent importer leurs légumes la plus grande partie de l'année. Des chercheurs de l'Université de Guelph sont à développer des tomates cultivées en pleine terre plus savoureuses, plus fermes, ayant une durée de conservation plus longue, une meilleure qualité et une plus grande tolérance au froid.

L'agression du froid déclenche l'activité du phospholipase D, enzyme qui déclenche la dégradation de la membrane cellulaire. Les chercheurs tentent de trouver un moyen d'enrayer cette activité à l'aide des techniques de biologie moléculaire. On s'attend que la saveur et la qualité gustative soient conservées étant donné que l'intégrité de la membrane cellulaire ne sera pas diminuée.

Dans le futur, le chercheur Gopi Paliyath espère utiliser cette méthode pour améliorer la durée de conservation, la qualité et la tolérance au froid d'autres fruits et légumes, y compris les pêches, les prunes, les cerises, les poivrons, les pommes de terre et les légumes-feuilles.

Performance Plants Inc.

Des récoltes plus résistantes et plus nutritives pour la planète grâce à des techniques d'ici

La compagnie Performance Plants a été créée par des membres du groupe de biologie végétale de la Queen's University en 1995. La compagnie se concentre sur l'utilisation du génie métabolique pour élaborer des variétés de plantes plus productives dont la valeur nutritive et la tolérance à des stress environnementaux tels que la sécheresse sont accrues. Une attention particulière a été portée au canola, à la luzerne, au soja et au maïs, bien que quelques-unes des techniques produites puissent être appliquées à une vaste gamme de cultures et au coton.

Une fois que la recherche

fondamentale et que des essais en nature sont effectués, Performance Plants cherche des partenaires corporatifs pour l'aider à mettre la dernière main aux techniques et à les mettre en marché. La Growth Enhanced Technology constitue l'un de ces produits qui, grâce à des lignées transgéniques de cultures, offre un rendement plus élevé que des cultures régulières lorsqu'il y a moins de lumière. Au nombre des autres techniques, mentionnons les gènes AMPLE qui favorisent des productions agricoles et d'huile plus abondantes; la tolérance au stress hydrique, qui gère génétiquement l'ouverture du stomate des feuilles pour ralentir la perte d'eau des plantes; la valeur nutritive, qui réduit le niveau de fibres dans l'alimentation animale et qui en améliore ainsi la qualité; la technique de stress au phosphate, qui suppose la modification de la capacité d'une plante d'utiliser le phosphate disponible pour améliorer sa croissance; et une meilleure synthèse de l'huile, qui permet d'augmenter le niveau d'huile dans la graine.

Questions de santé

Jouer au plus fin

Technologie des vésicules, la voie du futur pour les vaccins et les antibiotiques

De nouvelles possibilités de distribution des vaccins et des médicaments pourraient aider à combattre les bactéries antibio-résistantes et contribuer à l'émergence de meilleurs vaccins plus économiques. Le professeur Terry Beveridge du département de microbiologie utilise des vésicules de membrane pour distribuer les vaccins et les antibiotiques aux tissus et aux cellules.

Il existe deux types fondamentaux de bactéries : les bactéries Gram positif et les bactéries Gram négatif. Les bactéries Gram négatif ont la particularité d'éliminer les vésicules de membrane de leur surface. Les chercheurs espèrent élaborer un système de distribution des vaccins qui fait appel à des vésicules de membrane. Sur les parois cellulaires des vésicules se trouvent des antigènes, lesquels entraînent une réponse immunitaire lorsque l'organisme infecté les reconnaît comme étant « étrangers ».

Bien que ces vésicules, à l'abri des agents pathogènes, offrent une empreinte unique des bactéries – ce qui en fait des vaccins prometteurs –, elles présentent un certain taux de toxicité. Ces endotoxines signifient que les vésicules ne peuvent pas simplement être injectées dans un animal ou un humain, car elles provoqueraient une fièvre. La solution consiste à utiliser des bactéries vivantes qui ont perdu leur virulence ou leur toxicité.

En ce qui concerne le système de distribution des médicaments, Beveridge et son équipe ont mis au point une nouvelle technique qui consiste à introduire un antibiotique dans les vésicules de la membrane dérivées à l'origine des bactéries. Les pathogènes bactériens reconnaissent la vésicule de membrane comme la leur et l'acceptent. Lorsque les vésicules éclatent, l'antibiotique et les enzymes sont libérés et tuent la bactérie.

Des brevets sont en instance.

Le développement immunitaire stimulé par l'huile de lin

Le lin a plusieurs utilités, que ce soit dans les produits alimentaires pour le bétail, les peintures et comme supplément dans les régimes chez les humains. Il s'agit également d'une culture importante pour les fermiers canadiens qui produisent 40 pour cent du stock mondial.

À l'heure actuelle, le professeur Bill Woodward examine de quelles façons la consommation d'huile de lin peut améliorer le développement immunitaire. Différents ratios de deux types d'acides gras non saturés, n-3 et n-6, ont été comparés dans six types d'huiles végétales. La comparaison visait à déterminer quel ratio donnait des résultats optimums. Des diètes avec suppléments d'huiles ont été servies à des souris sevrées. L'huile de lin avait toujours un grand effet positif sur la réponse immunitaire.

M. Woodward croit que le niveau d'acides gras n-3 dans l'huile de lin est en partie responsable, bien qu'un bas niveau d'acides gras n-6 puisse jouer un rôle encore plus important.

Dénombrement des avantages du soja

Les planteurs, les industries transformatrices et les consommateurs, tous s'intéressent aux produits du soya riches en isoflavone

Les isoflavones sont des produits chimiques végétaux naturels que l'on trouve dans le soja. Les chercheurs du Guelph Centre for Functional Foods

évaluent les bienfaits pour la santé des isoflavones, ainsi que les moyens d'améliorer les rendements ainsi que les niveaux des isoflavones dans les champs.

Une étude tente de déterminer si la consommation d'isoflavones peut entraîner une réduction des niveaux de cholestérol. Une autre se penche sur les effets des isoflavones sur les cellules cancéreuses. Dans les champs, des études agronomiques cherchent des moyens pour augmenter les niveaux d'isoflavones dans les cultures de soja.

Norgen Biotek – services de soutien à la recherche dans le domaine de la biotechnologie

Norgen Biotek entretient des liens étroits avec l'Université Brock et une foule de spécialistes dans les domaines de la biologie, de la virologie et de l'immunologie. Cette société canadienne offre des services comprenant entre autres la synthèse et le séquençage sur mesure de l'ADN, ainsi que la construction de gènes pour l'expression par le client. La société a été fondée par le Dr Yousef Haj-Amad, professeur à l'Université Brock.

Le diagnostic est aussi un des champs de spécialisation de Norgen. Pour le virus leucémogène bovin et le virus du syndrome dysgénésique respiratoire porcin, Norgen utilise une méthode basée sur l'amplification en chaîne par polymérase (ACP) qui détecte l'ADN viral plus rapidement et plus précisément que les tests standard. Norgen est aussi en train de développer une trousse brevetée d'isolement de l'ADN qui minimise l'utilisation de produits chimiques dangereux.

Salubrité des aliments

Canadian Research Institute for Food Safety

CRIFS au coeur de la recherche en matière de sécurité alimentaire

Le Canadian Research Institute for Food Safety, ou CRIFS, a été créé dans le but de devenir le carrefour de diverses études sur la sécurité alimentaire. Plus de 100 spécialistes travaillent à réduire les coûts pour la société des intoxications alimentaires en mettant sur pied des projets de recherche en matière de sécurité alimentaire dans le cas d'inoxications d'origine microbienne, ce qui fait du CRIFS le plus grand institut de ce genre en Amérique du Nord.

Le Food Policy Centre est un institut associé qui sera également situé à l'Université de Guelph. Il permettra de faire connaître les résultats des recherches en matière de sécurité alimentaire aux décideurs.

Le CRIFS comprendra une installation de confinement de niveau trois grâce à laquelle des études plus complètes des organismes pathogènes dont les risques ne sont pas connus pourront être effectuées. La bactérie E. coli 0157:H7 constitue un exemple. Les chercheurs ont créé une souche lumineuse en insérant le gène provenant d'une luciole dans l'ADN de l'agent pathogène. Cette technique permet de surveiller la mortalité de l'agent pathogène au cours de la production de saucisses.

Un film que personne ne veut voir

Sur la piste des films biologiques dans l'industrie alimentaire

Les films biologiques sont des couches protectrices qui se forment autour de colonies de bactéries attachées à une surface. Les films rendent les bactéries plus résistantes aux méthodes et aux produits de nettoyage ainsi qu'aux antibiotiques. Des chercheurs sont en train d'élaborer des méthodes plus rapides et plus précises de détection et d'élimination des films biologiques et des bactéries qu'ils protègent.

Le professeur Heidi Schraft et ses collègues utilisent un nouvel équipement pour étudier trois micro-organismes pathogènes responsables d'intoxications alimentaires – Listeria, Campylobacter et E. coli. Elle veut déterminer si ces bactéries particulières formeront des films biologiques sur des surfaces solides, et, le cas échéant, si leur survie s'en trouvera améliorée dans l'environnement de transformation des aliments. La présence de films biologiques dans l'équipement de transformation des aliments a pu être la cause de différents problèmes de santé attribuables à des agents pathogènes d'intoxication alimentaire.

Des études connexes cherchent des moyens d'éliminer les films biologiques de l'équipement de transformation des aliments. Les enzymes et les courants électriques peuvent constituer des solutions.

Renseignements pour les consommateurs

La question de l'étiquetage

Certains consommateurs croient que les aliments produits à l'aide de la biotechnologie agricole devraient être étiquetés. Cependant, l'étiquetage est complexe et coûteux, et peut ne pas vraiment renseigner. Presque tous les aliments que nous consommons ont fait l'objet d'un certain type de modification génétique. L'ensemble du processus de modification génétique est soumis à des règlements stricts au Canada.

Les aliments prêts-à-manger en sont un exemple. Les boeufs et les poulets sont vaccinés à l'aide de produits génétiquement modifiés. Ils ont pu être nourris de maïs et de soja qui étaient également modifiés. Le blé contenu dans les pains, les tomates et d'autres garnitures ont pu bénéficier d'une certaine aide biotechnologique. Il en va de même de certaines huiles de canola durant la production, bien que l'huile qui en résulte ne contienne aucune trace de modification génétique. Le sirop présent dans les boissons gazeuses provient de fructose modifié, un produit du maïs, bien qu'aucune modification n'y soit décelable. Ces produits devraient-ils être étiquetés?

À quel point faut-il être précis dans l'identification des produits génétiquement modifiés, constitue une autre question à se poser. Il n'y a pas de niveau « zéro ».

Les consommateurs devraient également être conscients que l'étiquetage entraîne des coûts – quand il s'agit d'entreposer, d'expédier, de traiter et d'emballer séparément des aliments d'origine biotechnologique et les autres. Un projet d'élaboration d'une norme nationale pour l'étiquetage volontaire est en cours au Canada. À la limite, les Canadiens devraient être rassurés par le fait qu'il n'existe aucun exemple de maladie ou de souffrance chez les humains ou les animaux attribuable à des récoltes biotechnologiques. Notre système de réglementation se classe parmi les meilleurs au monde.

Déclaration de scientifiques en faveur du développement et de l'utilisation responsables de la biotechnologie

Plus de 150 scientifiques canadiens ont signé une lettre qui a été publiée dans les éditoriaux du National Post en novembre 1999. La lettre invitait les Canadiens et Canadiennes à prendre part aux discussions sur les questions de biotechnologie, des discussions basées sur des faits et sur la science. Les scientifiques soulignaient que le Canada jouit d'un système de réglementation des aliments et des drogues parmi les meilleurs au monde. On souhaite que la biotechnologie permette d'améliorer la santé de la population partout dans le monde et qu'elle aide à nourrir notre population croissante à l'échelle de la planète.

Les scientifiques ont mis sur pied une coalition nationale et encouragent leurs collègues de tout le pays à se joindre à eux pour accorder leur soutien à cette technologie importante et à son système de réglementation.