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The Food Processing Center News, Fall 2008

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FDST's College Bowl Team. Left to Right: Tim Anderson, Bailey Harris, Melanie Downs, Suzy Hammons, and Ryan Talley

FDST Students Star at IFT

This June, the Department of Food Science and Technology made the trip to the Institute of Food Technologists Annual Meeting in New Orleans. The students always leave their mark on the proceedings, but this year they stole the show.

Poi-Wah Lee, a Ph.D. candidate under Dr. Taylor, won first place in the IFT Graduate Research Oral Paper Competition, the most prestigious paper award at IFT. All abstract submissions from graduate students were eligible; so Poi-Wah's work stood out from over 660 abstracts. Six students were chosen to present their abstracts in a special oral competition, and a panel of judges selected the winner from that group. Poi-Wah won the award for her M.S. research on development of an ELISA for detection of mustard residues.

In addition, Anuja Patnaik won the Second Place Award in the Biotechnology Division Poster Competition, and two other students, Bhima Geera and Matt

Dickey, presented in the Carbohydrate Division paper competition. Other students in paper competitions included Melanie Downs and Ferdellie Gaskin. Three more students, Rakhi Panda, Harsha Ariyaratna, and Manjusha Kasinadhuni, presented their research at the poster sessions.

UNL also fielded a College Bowl Team consisting of Tim Anderson, Melanie Downs, Suzy Hammons, Bailey Harris, and Ryan Talley. The team made a great effort, but, unfortunately, came up short in its two matches and was eliminated in the morning rounds. Even though the College Bowl Team didn't come out on top, its members were thrilled to be one of only 8 teams to compete at the national level. This was the first time UNL's team has made it to the finals.

The Food Science Club was also one of 6 finalists in the Chapter of the Year Competition. Although the Club did not win this year, new Club President Olivia Kunzman has promised to aim for the top next year.

The 2008 Institute of Food Technologists Annual Meeting was certainly a success for the department. We can expect similar results for the June 2009 meeting in Anaheim, California.



The FPC's pilot plant membrane filtration system

Membrane Filtration Opportunities for the Food Industry

The Food Processing Center's (FPC) new pilot plant membrane filtration system offers food processors the capability to purify, concentrate, and clarify food products, as well as to recover valuable components from waste streams such as proteins from dairy whey, or starch and sugar residuals from vegetable and fruit processing. In addition, membrane filtration (MF) can enhance the taste, texture, and nutrition content of food products.

Membrane filtration is an energy efficient way to clarify, concentrate, fractionate, and purify a variety of fluids without thermal processing (evaporation). A thin film of porous polymer is the filter media that separates the solids from the fluid. Membranes may be made of other materials such as ceramic and stainless steel which are used for high solids applications (i.e., removing pulp from juices). Components smaller than the membrane pore size pass through the membrane (permeate) while larger components are retained.

Future applications for membrane processing may include the manufacture of fresh, soft, hard and semi-hard cheese varieties. Ultra Filtration (UF) concentrated milk, with its fat and protein content concentrated to 3.5X, and a portion of the lactose, ash and water removed, has the ideal composition for the manufacture of fresh cheeses like ricotta or brine cheeses like Feta. Replacing as little as 10-15% of the cheesemilk volume with

UF milk creates the opportunity to boost total solids, therefore increasing cheese throughput in a factory by as much as 18% and subsequently reducing production costs. In addition, because the UF permeate contains solids (primarily lactose), using UF milk could reduce a cheese plant's wastewater processing costs.

Membrane processes in cheese making may not be limited to the concentration of cheesemilk. MF can yield a casein-enriched cheesemilk that would be ideal for semi-hard cheeses like cheddar. This presents new possibilities in controlling the development of textural and sensory attributes.

If you are interested in using The FPC's ultra-filtration equipment, contact Steve Stephens at (402) 472-2901 or at sstephens2@unl.edu.

Food Safety Conference a Shared Success

6 interpreters, 13 presenters, 42 attendees from more than 20 countries, and about 100 hours of interpreter training and preparation, and The FPC and the Department of Food Science and Technology add a feather to their shared cap.

"Assuring Food Safety of Foods for Domestic Consumption and International Trade" was held May 12-16, 2008. The workshop gave an overview of food safety standards, regulations, and practices to government officials and industry representatives from across the Americas. The workshop was co-sponsored by University of Nebraska-Lincoln's Food Processing Center and Department of Food Science and Technology, and the Institute for Inter-American Cooperation on Agriculture (IICA).

Presented in both English and Spanish, with simultaneous interpretation provided by a team of specially trained Food Science students, the conference addressed a variety of issues. Food safety requirements placed upon internationally traded food products, risk assessment in food processing systems, protection against common contaminants, and good manufacturing practices in the food industry were all covered and discussed.

One challenge is that it's easier to mandate and enforce food safety standards at the processor level than at the producer level.

"You cannot expect the processor to clean up everything that comes through from the farm," Dr. Molins, Director of Agricultural Health and Food Safety for the Costa Rica-based IICA said.

Dr. Rolando Flores sees the workshop as more than just a chance to deliver information.

"This workshop was an opportunity for UNL to build relationships with decision-makers throughout Central and South America," Dr. Flores said. "We have representatives from the ministries of agriculture of 20 different IICA members attending this workshop. If we can open a dialogue with those governments and the food industries they oversee, it will help us establish UNL as a primary source of expertise and cooperation on food and agriculture for the entire Western Hemisphere."

"We want to develop collaborative links that can assist us in the future," Dr. Flores added.

The food safety experts who attended gained a powerful ally in The FPC; some returned for Spanish-language Better Process Control School taught in August, and others are tuning in to web seminars coordinated by Dr. Thippareddi this fall on controlling *Listeria monocytogenes* in ready-to-eat meat and poultry. More broadly, the IICA Food Safety conference laid the foundation for enhancing our role as a partner to countries whose agrifood economies are becoming more and more integrated with the US economy.

A Message From Dr. Flores

On behalf of the department, I am happy to welcome the newest member of our faculty, Dr. Dan Peterson. Dr. Dan Peterson came to us from Washington University in St. Louis. Dr. Peterson received his Bachelor's Degree in Animal Science from UNL. At Washington University he received a M.D. and performed a residency in Pathology. Dr. Peterson joins our faculty as a specialist in mucosal immunology, and we look forward to his contributions in the area of G.I. Research.

This issue features an article by Dr. Andrew Benson, the leader of the G. I. Tract Initiative at UNL. This is an exciting research area for our department and not the least because of new developments in the field and the new equipment Dr. Benson has recently acquired to extend our research capabilities. The new Roche 454 Pyrosequencer supports the Next Gen sequencing strategy, which provides analysis of hundreds of thousands of complex mixtures of amplicons from 16S rRNA PCR reactions. Previously, such studies could only be conducted at genome sequence centers with tens to hundreds of machines and an army of personnel. Now the same work can be performed by a small team in a week, enabling researchers to fingerprint an entire microbial community as a whole. This new technology has enormous potential for the study of health and can revolutionize the understanding of safety and flavor in food industry.

The Dairy Store has found a new helmsman in Bryan Scherbarth, who began as manager in early April. Bryan brings a wealth of experience in food service and hospitality, most recently managing the departed Lincoln destination P. O. Pears. Already the Dairy Store is expanding its menu, extending its hours, and is providing ice cream for more UNL sporting events and activities.

The Food Processing Center continues to expand its seminar offerings from the entrepreneurial, technical assistance, and outreach units. The Better Process Control School was offered for the first time in Spanish in early August and attracted more than 20 specialists from 6 countries. Other events on the schedule include Better Process Control School in September and an intense line-up of courses in October: the 18th Annual Applied Extrusion Workshop, Organic Foods Processing, and the Pet Food Technology Symposium.

The Food Technology for Companion Animals major continues to grow. This program is moving forward with the strong support of the pet food industry, especially from Nestle Purina. Five new students have joined the program this fall. An additional recruiter is also being hired to assist in recruitment efforts for this major.

The department of Food Science and Technology had a very strong showing at the Institute of Food Technologists conference in New Orleans. Dr. John Rupnow was conferred the distinction of IFT Fellow. Doctoral candidate Poi-Wah Lee won first place in the prestigious IFT Graduate Research Competition. Other student presenters included Harsha Ariyathna, Matt Dickey, Melanie Downs, Ferdellie Gaskin, Bhima Geera, Manjusha Kasinudhuni, Rakhi Panda, and Anuja Patnaik.



Rolando A. Flores
Professor, Head,
and Director

Dr. Hanna "Most Cited" Author of 10 Years



Dr. Milford Hanna

The latest issue of *Essential Science Indicator* unveiled the biofuels research paper most cited over the last 10 years. Food Science and Technology and Biological Systems Engineering professor Milford Hanna's 1999 article "Biodiesel Production: a Review," which was published in the October 1999 issue of *Bioresource Technology*, was cited over 300 times.

"Biodiesel Production: a Review" dealt with the methods by which animal fat and vegetable oil can be processed into mobile fuels. The article focused on conversion using the transesterification process, which is now the standard method.

Dr. Hanna's review, and the 2005 follow-up "Biodiesel: Current Perspectives and Future" provided a broad analysis of processing trends and industry concerns. This research is especially important given current energy concerns and the interest in alternative fuel sources.



Alumnus Bob Bidrowski

Bob Bidrowski, an Omaha native, is a graduate of the University of Nebraska–Lincoln's Department of Food Science and Technology. Bob is now the Quality Assurance Manager at the Nestle Purina PetCare Plant in Crete, Nebraska.

Bidrowski came to UNL for pre-veterinary studies but then gravitated towards Food Science. "My original major was Animal Science and I was pursuing completion of the pre-vet requirements. After a semester I determined that Food Science was possibly better aligned to the technical requirements of the pre-vet program. I had always been interested in chemistry and biology and the Food Science Program provided plenty of exposure to those disciplines. I think the small size was something that attracted me to the program. It seemed that the faculty was very approachable and available."

Bob's favorite memory of his time at UNL is a Dairy Product Judging Contest in Chicago. "It was exciting to be involved in the event. In addition, the van broke down on the interstate on the way to Chicago. Although this probably wouldn't be considered a good thing I think it helped build camaraderie with the team."

Currently, Bob's role is to assure the quality of companion animal products made at Nestle Purina PetCare. He elaborates: "It includes food safety, appearance and texture specifications, and nutritional and regulatory requirements. This involves developing, managing, maintaining, and improving quality systems and covers the process from raw ingredient quality through mixing, thermal processing, packaging and labeling, to distribution. This also includes managing a staff of technical personnel that carry out in-process evaluations and testing as well as chemical and microbiological analyses."

Bob is grateful for the education afforded to him and others by the department. "The education at UNL stressed the importance of food safety, which is the number one priority. In addition, the program offered exposure to many facets of the food industry and definitely kept students involved hands on."



Bob Bidrowski

Selected Grants

Mussehl Poultry Research Endowment

Jayne Stratton

"Prevalence and Detection of Mycotoxins in Dried Distillers Grains from Nebraska and other Midwestern States"

\$12,500 (1 year)

Nebraska Corn Board

David Rickert

"Whole Grain Corn Extruded Snack and Processing Effects on Natural Antioxidants"

\$49,750 (1 year)

USDA

Jeyamkondan Subbiah

"Improving the Safety of Prepared, but Not Ready-to-Eat Microwaveable Foods through Heat Transfer and Pathogen Destruction Modeling"

\$599,985.00 (3 years)

USDA Foreign Ag Service

Harshavardhan Thippareddi

"COCHRAN Fellows from India: Food Safety, Standards & Quality Training"

\$17,644 (14 months)

USDA/CSREES

Rolando Flores

"Midwest Advanced Food Manufacturing Alliance"

\$340,794 (1 year)

USDA/CSREES

Stephen Taylor

"Alliance for Food Protection"

\$121,305 (1 year)

USDA/CSREES-ISE

Michael Zeece

"Enhanced International Collaboration in Food Science Education and Research/Ireland Study Exchange"

\$99,981 (2 years)

MS Graduate Carolina Leguizamon

Carolina Leguizamon, a native of Colombia, graduated from the Department of Food Science and Technology with a Masters Degree this May.

Carolina's interest in Food Science begins with what she feels is the immediacy of the subject. "It is one of the sciences in which you see the application right away," she says. "It is easy to understand without too many abstract concepts and you feel you are working for the benefit of the people. I feel motivated to look for healthier, tastier and more diverse food products as well as alternative and sustainable sources of food products." Although she always wanted to study abroad, Carolina was pleasantly surprised by the diverse student body

at UNL. "I never imagined how much I would learn about other countries and cultures," she said.

In the course of her graduate work, Carolina has enjoyed a rewarding relationship with her advisor, Dr. Curtis Weller. "He was very practical and full of ideas all the time. He gives you a lot of freedom in the way to conduct your research, always inviting you to discover and analyze what is going on and he is very easy going and funny sometimes."

At UNL, Carolina conducted research on the byproducts of ethanol production from cereals, especially the byproducts from sorghum and corn, called DDGS (dried distillers grains with solubles). She investigated different methods of extracting plant sterols and policosanols from DDGS. These compounds have been attributed with cholesterol-lowering properties and DDGS are a potential source of extraction of these valuable compounds.

Currently, Carolina is working with the Risk Assessment team at The Food Processing Center. "I work on different projects at The Food Processing Center such as risk assessment of pesticide residues in cattle in Costa Rica and investigation of different equipments for the homogenization of soymilk. Also I collaborate on projects such as the french fries and cheese-making projects." She appreciates the hands-on experience she has at The FPC and plans to continue her education, receive her PhD, and return to Colombia "fully prepared to work there."



Carolina Leguizamon



Graduates of the B.S. Program

May

Monalisa Chen
Melanie Downs
Nuttawut Jiewchaloemmit
Chika Otani
Jared Schmid

August

Jason Krohn

Graduates of the M.S. Program

May

Tammy Gries, Thesis: "Capillary Electrophoresis for Metabolic Profiling of Inducible Inflammation and Anti-Inflammatory Properties of Resveratrol in Raw Macrophage Immortal Cell Lines" Susan Cuppet, advisor

Carolina Leguizamon, Thesis: "Influence of Extraction Method and Operating Parameters in Recovery of Lipids From Grain Sorghum and its Distillers Dried Grain with Solubles (DDGS)" Curtis Weller, advisor

August

Sudheendra Kadkol, Thesis: "Pulsed Electric Field Processing of Liquid Foods to Inactivate Microorganisms" Jeyam Subbiah, advisor

Saurabh Kumar, Thesis: "Evaluation of Cationic Antimicrobials on Growth and Survival of *Listeria Monocytogenes* on Frankfurters and Survival of *Escheria coli* O157:H7" Harshavardhan Thippareddi, advisor

Graduates of the Ph.D. Program

August

David Monsalve, Thesis: "Development of Predictive Models for the Growth of *Listeria monocytogenes* on Ready-to-Eat Meat and Poultry Products" Harshavardhan Thippareddi, advisor

ACCOMPLISHMENTS

UNL AWARDS

2008 UNL Research Fair

Manjusha Kasinadhuni - Outstanding Poster in the Biological and Agricultural Sciences Division

UNL Honors

Matthew Crotty
Melanie Downs**
Jamie Eggerss
Lauren Gemar
Susan Hammons
Laura Hargarten
Olivia Kunzman
Tessa Porter
Crystal Pribyl
Rachelle Struebing

** Melanie was named a Chancellor's Scholar meaning she completed all of her graded undergraduate course work with a perfect 4.0 GPA.

UNL Undergraduate Research Conference

Pei Tze (Emily) Ang, Sponsor: Randy Wehling
Melanie Downs, Sponsor: Steve Taylor
Jamie Eggerss, Sponsor: David Jackson
Susan Hammons, Sponsor: Jens Walter
Robert Lacy, Sponsor: Susan Cuppet
Shy Shi Lee, Sponsor: Vicki Schlegel
Rachelle Struebing, Sponsor: Vicki Schlegel

Widaman Trust Distinguished Graduate

Assistant Award

Andreia Bianchini
Phaik Lyn Oh



Daniela Bautista and Rigoberto, a dairy processor at Zamorano

Undergraduate Interns in Home Country

Food Science senior Daniela Bautista spent this summer studying at the Escuela Agricola Panamericana Zamorano in her home country of Honduras.

"I approached Dr. Flores with the idea of doing a cooperative project with Zamorano in order to compete in the IFTSA competition 'Developing Strategies for Developing Countries' for The 2009 IFT Food Expo Conference in California."

"I thought it would be interesting to work with a university abroad, especially one in a developing country. Such institutions work with the food systems that are quite different from United States." So the arrangements began.

"Being in Zamorano is a different experience. I moved from a relatively large university to one of about one thousand students total. The Department Head told me when I arrived that Zamorano is similar to either a military or a boarding school." The contrasts were not limited there: "Zamorano develops individuals who have experience working in varied areas in agriculture, from working in producing crops to processing to selling. UNL teaching is more focused on what you are studying and pure research. Individuals develop differently due to the size of the institutions and so on," Daniela observed.

Daniela has found her internship very rewarding. "I am learning and strengthening concepts and abilities here in Zamorano. Academically, I have learned a lot of practical things. I have reinforced learned theory with practice on dairy production and I have caught a glimpse of what it is like to work in a meat production plant, from slaughtering to processing. In the application part, I worked with the product development team helping local small and medium scale food companies in producing products viable for the market. Professionally, I saw more what it is like to work in a team setting. I realized that I must learn how to negotiate my ideas if I want to get them through or at least to have them be considered viable and efficient."

Daniela hopes that her experiences this summer in Honduras will aid both her future and the future of her two "home" universities. "With this endeavor, I am not only seeking to be one of the first students working in a collaborative project between both universities, but also looking to grow professionally by gaining experience in how a processing plant functions. I want to gain a better idea of how my country's industry might be developing in comparison to fellow developing countries and what ideas or strategies can be borrowed to improve our food system."



ACCOMPLISHMENTS

NATIONAL

American Association of Candy Technologists Scholarship
Tessa Porter

IFT

Graduate Research Oral Paper Competition

Poi-Wah Lee, 1st place

Biotechnology Division Poster Competition

Anuja Patnaik, 2nd Place

Carbohydrates Division Competition

Matt Dickey, 2nd Place

Bhima Gheera, 3rd Place

UCARE (AND FACULTY SPONSORS)

Emily Ang Pei Tze, Randy Wehling
Daniela Bautista, Robert Hutkins
Kristen Cochran, Richard Goodman
Matthew Crotty, Stephen Taylor
Jamie Eggerss, David Jackson
Lauren Gemar, Robert Hutkins
Susan Hammons, Jens Walter
Laura Hargarten, Michael Zeece
Bailey Harris, Vicki Schlegel
Robert Lacy, Susan Cuppett
Soo Low, Lloyd Bullerman
Kristy McCarty, Susan Cuppett
Tessa Porter, Michael Zeece
Grant Wallace, Jens Walter

Graduate Student Spotlight: Tim Anderson

MS Student Tim Anderson has a habit of being busy. In addition to putting in more than his fair share of hours in Dr. Thippareddi's lab, Tim has a busy schedule outside of class. "I am very active in the Food Science Club, where we have monthly meetings, and monthly fun events. We take food industry tours over fall break, and a group of us go to a food industry conference each summer hosted by the Institute for Food Technologists. This year at the conference, myself and four others represented the University of Nebraska–Lincoln in a National Quiz Bowl competition. For fundraising in the Food Science Club, we sell ice cream at the State Fair. I am the manager of one of the two booths. For intramural sports, I have played softball, volleyball, broomball, flag football, floor hockey, and indoor soccer."

Tim, a Minden, Nebraska, native, began at UNL as an undergraduate in 2003. His career in Food Science began with an interest in food. "I have always been interested in food. At first I wanted to be a chef, but school was very expensive, and I had always wanted to go to UNL. I came to UNL and asked what they had close to food. They showed me food science and Dr. Cuppett, and I kind of fell in love with it right then."

Dr. Cuppett served as Tim's undergraduate advisor and taught one of his favorite courses, Sensory Evaluation. "It was very hands on and applied. We would talk about what professionals would do in different situations and then we would actually do it. Similarly, our reports had to be very formal and professional. Very helpful with personal skills, writing skills, and we got to work with food."

Tim especially appreciates the opportunity to work with his advisor, Dr. Harshavardhan Thippareddi. "I started working for him the fall of my sophomore year and liked working for and with him so much that I decided to go into graduate school in his lab. He enjoys researching and coming up with different experiments. He teaches HACCP, a safety course for the food industry, so he has a lot of interaction with the food industry. We are able to go into food processing plants and sample, have access to different products, and help the industry with any food safety issues they may be having. Also, I am interested in working in the food industry in food safety or an area that works with HACCP, so this is a great experience for me. In Dr. Thippareddi's lab we do a lot of predictive microbiology research. We work with several foodborne pathogens, such as *Salmonella* spp., *Listeria monocytogenes*, *E.coli* O157:H7, *Clostridium perfringens*, and others. In one project, we are evaluating several systems to decontaminate seeds for sprouting and improve the safety of sprouts, and in another we work with meat and meat products to monitor growth of different pathogens in different conditions."

For Tim, it's almost impossible to point out a favorite experience at UNL. "This is a really hard question, because I have had so many great memories and experiences here. If I had to pick one, it would probably be in the co-rec softball championship game last summer. We had a team called The Ragin' Pathogens, which was comprised of food science students and a professor or two. We ended up making it to the championship game, and were up by 2 runs in the last inning. They had two runners on with two outs, and the guy at bat hit the ball to deep left center, where I was playing. I remember running all out, and had to reach as far as I could to make the catch for the third out. But I would have never been able to make that catch in such an important situation without the rest of the team."

New M.S. Students

Maria Calle Madrid
Advisor: John Rupnow

Melanie Downs
Advisor: Stephen Taylor

Andrew Hoppe
Advisor: Michael Zeece

Valli Kannan
Advisor: Harshavardhan Thippareddi

Pei Win Lim
Advisor: Stephen Taylor

Sely Prajitna
Advisor: Randy Wehling

Tara Stiles
Advisors: Jayne Stratton/Rolando Flores

New Ph.D. Students

Steven Frese
Advisor: Jens Walter

Roberto Jimenez
Advisor: Andrew Benson

Bo Hyun Lee
Advisor: Susan Cuppett

Junjie Ma
Advisor: Andrew Benson

Nyambe Lisulo Mkandawre
Advisor: David Jackson

Maria Elisa Perez-Munoz
Advisors: Rolando Flores/Jayne Stratton

Benjamin Remington
Advisor: Stephen Taylor

Audrey Wesseling
Advisor: Jeyamkondan Subbiah

From Culture-based Methods to DNA Sequencing of Entire Ecosystems: A Major Shift in the Paradigm of Diagnostic Microbiology

Research being conducted by Andrew K. Benson, Robert Hutkins, and Jens Walter,
Department of Food Science and Technology, University of Nebraska

In 1648 Anthony Von Leeuwenhoek first visualized and described “animalcules” with the help of his crude microscope. Known later as “bacteria,” it would take another 200 years before the founding fathers of microbiology (Robert Koch, Louis Pasteur, and Ferdinand Cohn) demonstrated conclusively that these intriguing “micro” organisms played direct roles in important processes such as human and animal disease or fermentation and spoilage of foods. Paving the way for their discoveries in the late 1800s were newly developed methods for propagating individual strains or isolates of bacteria in “pure culture”. Pure culture techniques allowed researchers to classify these organisms and introduce them in “pure” form into animals or unfermented food to demonstrate that a single species present in these isolated cultures could cause the disease or bring about fermentation.

Despite being a very robust method, studying microorganisms in “pure culture” in the laboratory oversimplifies what is usually a very complicated situation. Microorganisms typically reside as large communities of species within soil, water, air, and food, where they form highly complex ecosystems. In the human gastrointestinal tract, for example, about 2000 species make up a community of nearly a trillion bacteria (more than the number of cells in one’s body). Studying the entire ecosystem (e.g. a systems approach) has never been possible because only 10-20% of the species that reside in any given ecosystem can be successfully cultivated in pure (or even mixed) culture. Moreover, it is an expensive and massive undertaking to evaluate multiple species present in an environment using culture-based methods. Thus, the reductionist approach of studying a single species or a few representative species in “pure culture” has been the pillar upon which most mainstream microbiology has progressed.

Just like the other subdisciplines of microbiology, diagnostic microbiology has been totally dependent upon our ability to isolate and propagate microorganisms in the laboratory. And we have learned that certain pathogens such as Salmonella and *E. coli* O157:H7 are often present at very low levels and are non-homogeneously distributed in food samples. Thus, even the most robust culture-based detection methods are highly susceptible to sampling error. To circumvent the sampling problem, the “indicator organism” concept was developed in the 1950s. This ingenious concept, rather than look for a single pathogenic species, infers the relative risk that a food is contaminated with pathogens by testing for the presence of organisms that come from the environment where pathogens normally reside. Of course, with respect to foodborne pathogens, the most risky ecosystem is feces, from individual sources or from collective sources such as sewage or runoff. By using the “indicator organism” concept, one could test the food for organisms that are commonly present in feces in high numbers (much more abundant in feces than any pathogenic species). Over time, good old generic *Escherichia coli* (and a few other closely related species) became the indicator organism of choice and testing for it remains one of the most common approaches used for risk assessment in food and water microbiology.

Questioning the paradigm: Will the best indicator please step forward.

The choice of *E. coli* as the indicator organism was based on the facts (as understood at the time) that the species *E. coli* is relatively abundant in feces (1,000,000 cells per gram); that it is common to nearly all mammalian species; that it has primarily a gastrointestinal habitat; that it generally remains viable in the sample; and that it is relatively simple to culture and confirm. However, work in the last two decades has begun to show that *E. coli* is really only a very minor component of fecal material. In fact, strictly anaerobic species belonging to genera such as Bacteroides, Clostridium, Eubacterium, Fecalibacterium, and Bifidobacterium comprise much more of the physical bulk of feces and are present at five to six orders of magnitude higher levels in feces and GI contents (e.g. 10¹¹-10¹² per gram) than *E. coli*. Thus, use of *E. coli* as an indicator of fecal contamination severely curbs the detection limit. So why not use these other species? The answer to that question is based simply on the specialized conditions necessary to cultivate these organisms, which are certainly not practical for a modern high-throughput diagnostic microbiological testing facility.

Along came massively parallel DNA sequencing: An alternative to culture-based diagnostic methods.

In the aftermath of the massive effort of sequencing the human genome, a fierce competition has heated up to develop a “machine” that can sequence the human genome for under \$1,000. Such capability would lead to huge changes in “individualized medicine and health care” (definitely subject material for subsequent news articles from this author). Amid this technological arms race, a breakthrough was made in 2003 that allows the determination of DNA sequences from hundreds of thousands to millions of segments of DNA simultaneously (in parallel). This quantum leap in capacity allows a single machine to accomplish in 48 hours what used to take an entire room full of machines and an army of staff a month to achieve. Thus, DNA sequences from hundreds of thousands to millions of DNA segments can now be obtained quite easily using this Massively Parallel DNA Sequencing methodology (also called Next Generation sequencing, Next Gen for short). Most apropos to diagnostic microbiology is



Andrew K. Benson, Ph.D.
Professor
UNL Department of Food
Science and Technology

Continued on page 7

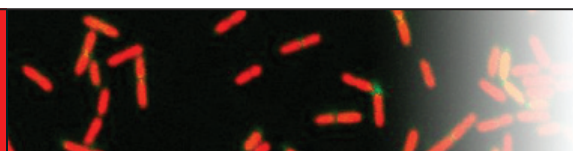
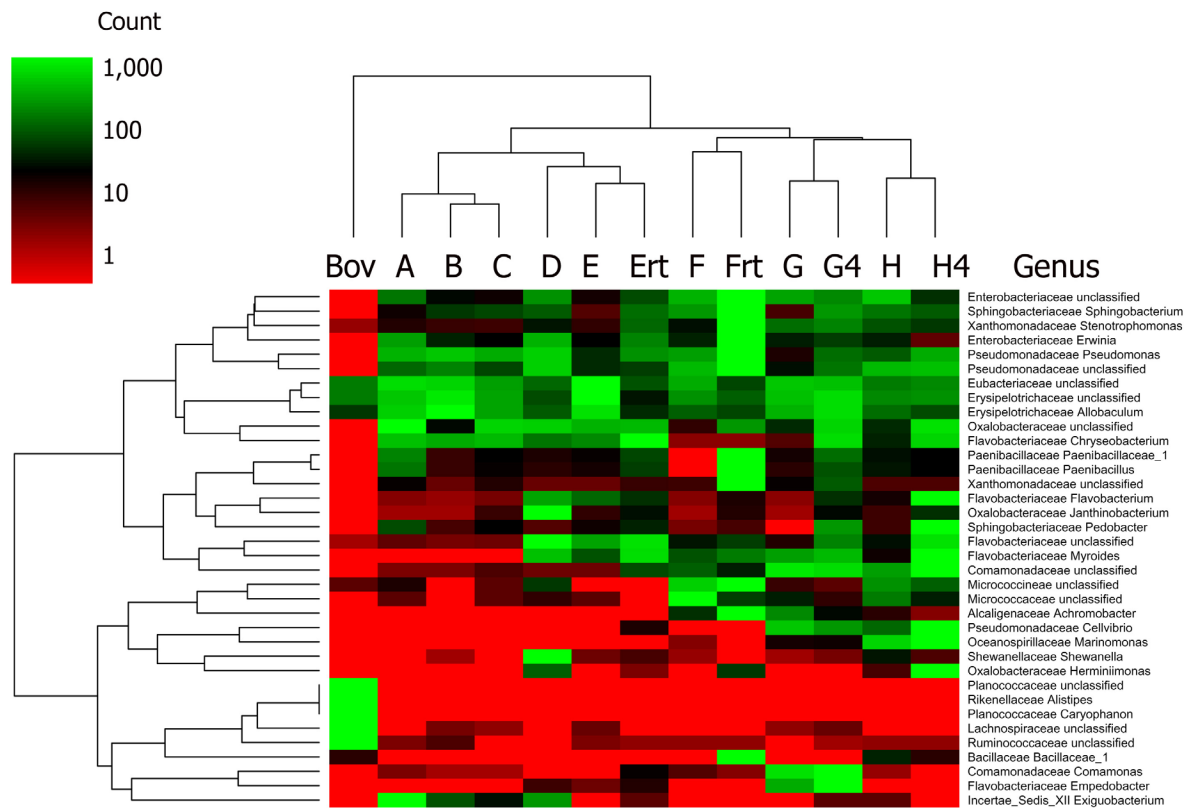


Fig. 1. Heat map of the top 36 genera in spinach samples. Spinach samples from bagged brands A, C-H and fresh bunched brand B were obtained over a one-month period from local grocery stores. Four of the samples were also stored at room temperature (Ert and Frt) or 4° C (G4 and H4) for 72 hours. The sample “Bov” was extracted from bovine manure. DNA was extracted from the leaves or manure sample immediately after purchase or temperature treatment and a segment of the 16S rRNA gene was amplified from the DNA populations by PCR. The PCR amplicons were then subjected to Next Gen sequencing on the Roche-454 GS-FLX Pyrosequencer at a level of ~ 10,000 reads per sample. Taxonomic assignments were made for each sequence using the database of the Ribosomal Database Project (RDP database). The counts of the top 36 taxa at the genus level were then normalized and subjected to two-dimensional clustering based on abundance of each of the genera in the different samples. The relative counts corresponding to the different colors on the heat map are shown in the upper left.



that we can use Massively Parallel, Next Gen DNA sequencing now to accurately quantify hundreds of thousands to millions of bacteria present in a sample without culturing them.

The concept is relatively simple. When bacterial DNA is extracted directly from the sample, no growth of the bacteria is required provided there are only relatively low amounts of contaminating DNA from animal or plant tissues present in the food. Next, we use PCR to amplify a segment of the 16S ribosomal RNA (16S rRNA) gene exclusively from the bacterial DNA. Because all bacterial species possess this gene and it evolves very slowly, it has been used extensively as chronometer for evolutionary biologists to study genetic relationships among bacterial species. Consequently, huge databases of 16S rRNA gene sequences from thousands of species are readily available. Thus, we can use Next Gen sequencing to sequence easily hundreds of thousands to millions of the 16S rRNA PCR products amplified from DNA that is extracted from a food sample. We then simply count the numbers of each different species that is present in half-million to one-million sequences that are generated, giving us an incredible snapshot of a very complex bacterial community without any culturing. This entire process can be accomplished by a single individual and a single Next Gen machine in a 48-hour period.

So how do we capitalize on this technology? Having such a powerful diagnostic technique now challenges us to rethink completely how we might go about risk assessment. Instead of looking for a single “indicator organism” in a food sample, we can now look at the entire population of microorganisms in a food sample and ask if the community of organisms present is the expected species that normally occupy that food or if the sample contains numbers of unexpected species, and in particular those species that are unique to fecal or soil environments. Thus, our assessment of “risk” is now based on the entire population, including the most abundant species of fecal and soil communities. Because our assessment is based on the entire composition, multiple species that are unique to feces or soil can be used in the determination, making the assessment much more accurate and robust. Moreover, the assessment is not limited to “risk” as we can also determine if the microbial community in a food sample has shifted toward spoilage (which gives us shelf-life predictions) or is consistent with “good” organoleptic properties of the food. The list of applications goes on and on.

Quick to the table: USDA funds its first Next Gen sequencing grant for food testing.

Drs. Benson, Walter, and Hutkins in the Department of Food Science and Technology are using Next Gen sequencing to study the GI microbiota and are also pioneering the use of Next Gen sequencing for diagnostic testing in foods. The three were recently awarded a grant from USDA-NRICGP to determine if the community profiling concept using Next Gen sequencing is indeed valid. The studies will focus on spinach as the model food and will use Next Gen sequencing to determine if the community of microorganisms present on spinach leaves is predictable (meaning that it is controlled by simple factors such as cultivar differences or geographic/climatic differences). They will proceed to determine how sensitive the Next Gen sequencing approach is to detecting fecal and soil contamination as well as temperature abuse. Dr. Benson, who spearheads the Gut Function

Continued in “DNA Sequencing” page 9

New Faces



Tina Ahrens began in the Filley Hall Business Center in March as a personnel associate. "I have found that the people around here are some of the friendliest you could find."



Joey Best began in June as the department receptionist and MAFMA grant administrator. She had previously worked as a project assistant with FARRP.



Lynda Clause began in March as an Accounting Associate. "I live inside of SAP, Excel, and Quickbooks." Lynda enjoys writing about food at her blog <http://LNKitchen.blogspot.com/>



Rebekah Lowe rejoined the FARRP lab as a Research Technologist in July. Rebekah worked with FARRP before earning her Bachelors in Food Science in 2007.

Dr. Daniel Peterson (see right)

Visiting Faculty

Dr. Soo-Hyun Chung is visiting us again from Korea University in Seoul, South Korea. He has been working with Drs. Bullerman and Stratton.

Dr. Itzhak Ofek recently worked with Dr. Hutkins. Dr. Ofek is with Tel Aviv University, Sackler Faculty of Medicine, Tel Aviv, Israel.



Dr. Daniel Peterson

Professor of Mucosal Immunology Joins FDST

This Fall, the Department of Food Science and Technology welcomed a new faculty member, Dr. Daniel Peterson.

Dr. Peterson grew up near Lincoln and earned his Bachelor's Degree from the Department of Animal Science at UNL. He attributes his initial interest in the mechanics of immune systems to his experience raising animals, and, in particular, "using vaccines on pigs to protect them from disease. Then during college, I read a very influential article by Philippe Marrack describing a key set of immunologic proteins (the major histocompatibility complex) that largely control the outcome of transplants, infections with pathogens, and autoimmunity. To learn more, I ended up working with a young faculty

member in the biology department at UNL named Bill Wade. I found that I loved learning through research and continued from there. In the last few years I have become interested in the ability of the immune system to control and influence the normal microbial community that lives on the surface of our body and inside our gastrointestinal tract even though the immune system can only act through the secretion of antibodies and antimicrobial peptides."

Dr. Peterson received his M.D. and his Ph.D. from the Washington University School of Medicine-St. Louis. Since gaining his doctorate in 2001, he has trained at the school as both a Clinical Pathologist and post-doctoral scientist. He went on to join the faculty as an Instructor in the Department of Pathology and Immunology while finishing his research.

About UNL, Dr. Peterson says, "The community here is truly unique as there are few places that have three labs already working on gut anaerobic microbes, and even fewer with the dedication to support the establishment of a new germ-free mouse facility. In addition, the importance of Nebraska as a leader in food allergy research, the dark side of mucosal immunology, created a terrific environment for me to bring my type of research."

Dr. Peterson elaborated on his research and role he envisions for himself at the University of Nebraska: "My appointment is primarily a research faculty position where I hope to teach and train graduate students and post docs both in my lab and in the classroom. I also have a secondary appointment at UNMC, where I hope to see more of the applied work that happens in the Food Science Department translated into therapeutic applications. I am particularly excited by the potential that exists to work with the world-renowned gut transplant group at UNMC. They provide a heroic treatment for some extremely sick patients, and I see a great opportunity for the fruits of the projects that we are going to develop in the Food Science Department to be applied in this population. As a physician-scientist with an interest in Food Science, I see translation of what we do in the Department into clinical research, whether it be in the area of gut transplant immunology, colitis patients or food allergies, to be one of my unwritten mandates."

The research Dr. Peterson plans to conduct centers on gnotobiology. In this system, test animals are raised in a completely sterile environment and lack bacteria even in their own systems. "We then have the opportunity to introduce specific microbes and observe how they impact the animal, and, conversely, how the animal changes the microbe. Setting up a new facility to do this will be a great challenge from the start, but it was very exciting to find at UNL a strong history and an ongoing program studying gnotobiotic livestock animals. This means that I am not starting from scratch but really adding onto an existing program. With this powerful tool we will be able to address many questions previously impossible to ask because of the normal complexity of the microbial community that cannot be controlled otherwise."

He continues, "This model of mucosal immunity in the gut will take advantage of information coming out of the NIH Microbiome Initiative, which is sequencing the genomes and genes of the

Continued in "Peterson" page 9



DNA Sequencing *Continued from page 7*

Initiative at UNL, was awarded funding to purchase a Roche-454 GS-FLX Pyrosequencer, a top-of-the-line Next Gen DNA sequencing system. Nearly \$1 million was invested in the Pyrosequencer, the supporting equipment, and bioinformatics architecture required to house and analyze the massive amounts of DNA sequence data. The machine was installed in Dr. Benson's laboratory in April 2008 and is offered as a service to other UNL scientists through the Core for Applied Genomics and Ecology (<http://cage.unl.edu>). In addition to diagnostic microbiology, Dr. Benson and the members of the Gut Function Initiative use community profiling by Next Gen sequences as a primary method for analyzing the effects of food and host genetics on the composition of the gut microbiota in humans and animal models.

Dr. Benson's Core for Applied Genomics and Ecology (CAGE) offers a workshop on Next Gen sequencing on October 28-29, 2008 at UNL. To find out more and register, visit <http://cage.unl.edu> or call 402-472-2816.

Peterson *Continued from page 8*

microbes that inhabit us. I am particularly interested in using this information to help discover what the immune system normally recognizes in the gut microbial community. In the past, these questions were too daunting because finding the part of a microbial community to which the body responds was like finding a needle in a haystack. The microbiome project is like having someone go through the haystack and name all of the straws and any needles they might find. Combining the new gnotobiotic facility with the infrastructure that is already in place, like the DNA Pyrosequencer, that resides inside the food science department, we can design and execute experiments on par with almost any institution in the world."

Dr. Peterson has full plans for his time at UNL. Off campus, his time also seems to be taken. "I have four kids aged 9, 6, almost 4, and 2. Anything that resembles free time I spend with them. I am also looking forward to using the bike trails around Lincoln, as they have expanded a lot in the last 15 years."



Fresh cheese from the UNL Dairy Store

cream developed at UNL. Tours, subject to availability, are scheduled Monday through Friday. Current hours are 10:00 am to 4:00 pm.

Connie Gebhardt, Graduate Secretary for the Department of Food Science and Technology, is now the contact person for scheduling tours for the Dairy Store. Connie has been with the University for twenty years, coming to Food Science and Technology from the Athletic Ticket Office. The Tour Line is intended for groups of 10 people or more. If you are interested in a tour, you can contact Connie at (402) 472-5323.

We also invite volunteers to assist in giving tours of the Dairy Plant. These individuals will be giving tours to groups from day care centers, elementary, middle, and high schools as well as other groups learning about the food processing business in Nebraska. If you are interested in joining a fun team, please give us a call at 472-2831.

Dairy Store Expands Tour Operations

The UNL Dairy Plant and Dairy Store have been producing and selling cheese, ice cream and other products for over 90 years. Visitors now have a chance to see "the backstage" of production, learn about the processes and stock up on UNL trivia. Of course, no tour of the Dairy Store is complete without a bite to eat or choosing a gourmet cheese to take home. The store offers a variety of options for breakfasts, lunches, and dinners as well as a dozen unique flavors of ice



Dairy Plant Manager Jonathan Hnosko preparing ice cream mix for freezing

New Flavors and Faces at the UNL Creamery

Jonathan Hnosko started as Dairy Plant Manager in January. Since his arrival at the UNL Creamery, several new products have been made available. The fresh hand-stretched mozzarella cheese has been a great success. Various cheese dips, such as Spinach & Garlic and Spinach & Artichoke, have also been well received by the Dairy Store's customers.

Together with Food Technician Kathy Vokoun and Technology Transfer Manager Laurie Keeler, Jonathan has been hard at work on exclusive new ice cream flavors. Morrill Orchard Medley, developed especially for the Justin Smith Morrill Scholars Program, combines native Nebraska ingredients in pear ice cream with a black raspberry ribbon, hazelnuts, and diced pear pieces. Centennial Apple Spice, developed to celebrate the Teachers' College 100th Anniversary, combines vanilla ice cream with spiced apple chunks in a caramel swirl. Brownie Fudge Swirl and Vanilla Frozen Yogurt are the latest additions to our list. Needless to say, we are excited to see what's next!



FPC Pilot Plants Assist Kansas Charity

In June, undernourished families in Xia-Xia, Mozambique, received 17 pallets of easily storable, nutritious grain product from the non-profit organization Grains for Hope. The majority of these lentil-like pellets that will feed undernourished women and children was formulated and manufactured on the twin-screw extruder at The Food Processing Center.

Grains for Hope was started in 2002 by Carol Spangler, a high school teacher in Sabetha, Kansas. The goal of the organization is to allow students to learn by addressing real world problems. The vision of the organization is to develop youth into practical, critical thinkers and responsible, ethical leaders, while empowering them to make a difference by providing populations in need throughout the world with the proper food, materials, education, and training to help them improve and enrich their quality of life.

Grains for Hope first came in contact with The FPC through mutual business partners Wenger Equipment and The XIM Group. Grains for Hope founder Carol Spangler said, "UNL is noted for being a university that offers students outstanding grain and food science technology and programs."

The goal of the project was to create a processed grain product for easy storage and shipment. ADM was among the corporations that donated precooked vitamin fortified rice and lentils for processing. The Food Processing Center donated formulation and extrusion services. Pilot Plant manager Steve Weier says, "This year we helped by processing 14,000 lbs. of reformed rice and lentils through our extrusion facility. The basic process of producing the food is to formulate the dry ingredients, typically rice, wheat, bean, or corn flours in the proper ratios and then fortify the blend with vitamins and minerals. This blend is then processed through our twin-screw cooking extruder. The extruder cooks and forms the ingredients into a shape similar to a rice kernel or a lentil. The product is then run through our dryer to bring the moisture level down below 12% for shelf stability."

Grains for Hope visited The Food Processing Center. The group toured the facility and assisted in processing the foodstuffs. Spangler adds, "Dr. Rolando Flores very kindly encouraged Grains for Hope personnel to participate in a tour of UNL while preparation for the extrusion of our product was taking place."

In addition to the 14,000 lbs. of food processed by The FPC, Grains for Hope received 6,000 lbs. processed at Kansas State University and Crosswind Foods. This product was bagged by volunteers in early June and soon shipped to Mozambique. As Spangler put it, "Any time people are able to connect in a more positive way, it is a success."



Lab Mechanic Tom Dobesh monitors extrusion for Grains for Hope

Help others who share your hunger for food science.

Donations to the Food Science and Technology Fund are used to enhance undergraduate recruitment. To contribute online, go to www.nufoundation.org/foodscience. To learn more, please contact Ann Bruntz, IANR Director of Development, University of Nebraska Foundation, 402-458-1176, or e-mail her at abruntz@nufoundation.org.



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Microbiology Laboratory Manager Expands Role

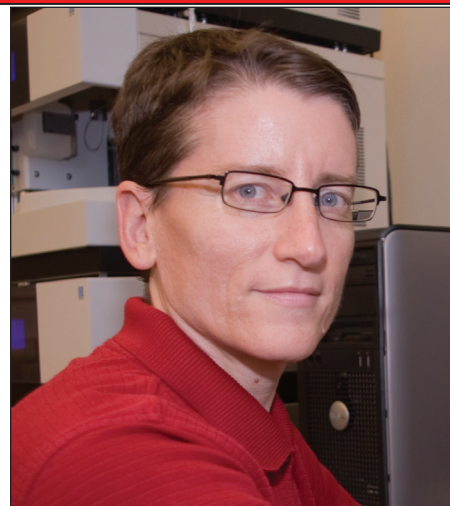
Dr. Jayne Stratton has been a part of the University of Nebraska–Lincoln since 1986. She graduated with a B.S. Degree in Biology and later earned her Masters and PhD from the University of Nebraska–Lincoln as well, focusing in the fields of Food Microbiology.

Dr. Stratton served as the manager of the Biological Process Development Facility for nine years before joining The Food Processing Center's Laboratory Services, which provides microbiological testing for the food industry. Her many years of experience in microbiology, management, and laboratory testing have made her the perfect match for the role of Research Assistant Professor in The Food Processing Center. Under her management, The Food Processing Center Laboratory has been incorporating new testing services such as real-time PCR detection of bacterial pathogens, rapid Salmonella serotyping by genetic analysis, and mycotoxin analysis by HPLC and ELISA. Over the course of her career, Dr. Stratton has published research and contributed to diverse forums on different food science topics.

Dr. Stratton networks frequently on food safety issues and laboratory methods through her membership in the International Association for Food Protection, the American Society for Microbiology, and the Society for Applied Microbiology. In addition to experience in food safety, she also has training in food defense and oversees The Food Processing Center's Acidified Foods Program.

Two new programs are being coordinated by Dr. Stratton. The Food Processing Center's Graduate Student Program enables graduate students to pursue an MS by conducting work with The Food Processing Center staff in applied research projects. Another new program, the Applied Research and Engineering Unit, has been established within The Food Processing Center to provide innovative and diverse research and technical assistance to clients in the food industry through the use of its dedicated laboratory and pilot-scale facilities.

In addition to Dr. Stratton, The Food Processing Center Laboratory employs one Research Technician, Robin Krokstrom, to help with day-to-day activities and the processing of samples. In the fall of 2008, two new graduate students, Tara Stiles and Maria Elisa Muñoz, joined The Food Processing Center Graduate Program. The addition of these and other graduate students in the future will bring a new direction to The Center by greatly enhancing its research capabilities while allowing students to gain hands-on experience in processing and unit operations.



Dr. Jayne Stratton

Sweet Success



Tessa Porter fighting with taffy

It all started with a student and her taffy. In late 2006, Food Science undergraduate Tessa Porter joined the staff of The Food Processing Center (FPC) Product Development lab as one of several students that The FPC hires to work there every semester. Tessa was also one of the finalists for the American Association of Candy Technologists contest and needed to submit a 5-minute video. She asked to use the lab to shoot a video of herself making taffy.

This started a chain of events in The FPC. Tessa won her scholarship. Other students thought the taffy looked like lots of fun to make. With the added demand, Laurie Keeler (General Manager for Food Technology Transfer) thought that The FPC might need some confectionery equipment.

Through generous funding from IANR, The Food Processing Center now has several pieces of confectionery equipment. These are a Savage Brothers Fire/Mixer Cooker, a stainless steel cooling table, and a cut/wrap/twist packaging machine. Though a taffy puller was sought, financial considerations had to put the purchase of that expensive piece of equipment on hold. Until it can be acquired, taffy pulling is being done by hand.

The equipment will be used to make products such as taffy, caramels, dessert sauces, and other confectionery products. These will be available for sale in the Dairy Store and offer fun demos for students and tours. The confectionery equipment will also expand the capability of The FPC to accommodate client projects. With the current concerns for childhood obesity and overall health, this new equipment will help develop low-calorie treats as well as products with a reduced glycemic index and other added "wellness" benefits.

Though recently acquired, the confectionery equipment is already showing an impact. Several companies have indicated an interest in running trials on new nutraceutical ingredients, sugar alcohols, or resistant starches and fibers using the equipment. The Dairy Store is developing new unique ice cream toppings as well as taffy using their signature ice cream flavors. High-schoolers visiting the campus can now see students really making taffy and learn the science behind it. It all started with a student and circles back to improving student experiences, offering new processing assistance to clients, and developing good and "good for you" treats to sell in the UNL Dairy Store.

To schedule trials or find out more information, please contact: Laurie Keeler @ 402-472-7803 or lkeeler1@unl.edu.

Alternative Microbiological Testing: Pyrosequencing

October 28-29, 2008–Lincoln, NE

Food Allergens: Issues and Solutions for the Food Product Manufacturer

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Food Entrepreneur Program Workshops

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March 9, 2009 –Lincoln, NE

Mold and Mycotoxins in Food

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Acidified Foods Better Process Control School

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