

Nonthermal Processing Division Newsletter



Volume 10, Issue 3

May 2009



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MESSAGE FROM THE CHAIR



Dr. Dallas Hoover

Professor, University of Delaware

Hello NPD members,

As we look for the emergence of spring weather (why is it taking so long?), we might also look ahead to the IFT AMFE in Anaheim that starts the first weekend in June. Like most IFT divisions, the majority of activities of the Nonthermal Processing Division (NPD) occurs at the summer IFT meeting, and as what often passes as normalcy, everyone at the meeting seems pulled several directions at once, day-or-night. So as we slowly gear-up for Anaheim, it may prove valuable to gather as much comment and insight from the entire NPD membership as possible. Long past practice in the NPD has been monthly conference calls for the Executive Committee. I think it is safe to say that the NPD ExCom is very aware of each other, but what about the majority of NPD membership not privy to the call? Not to leave the remainder of the NPD behind (or no stone unturned), it would be valuable to collect as much feedback from membership as possible as there always appears to be something in need of improvement or adjustment. Most IFT divisions have issues with declining membership, limited budgets, an annual need for new members *active* in division affairs, and the need

to deal with occasional problems in communication, whether intradivisional, interdivisional or within the body of IFT as a whole. The NPD budget has been in decline for the past several years so we are currently reviewing our activities in order to prioritize their perceived value. We do not want to backslide and not deliver as expected, especially for our student membership and our AM technical program. So as we look towards summer, I hope that any NPD member who reads this newsletter blurb will consider thinking some profound NPD thoughts and if any emerge, please bring them to the attention of any NPD ExCom member; contact information of NPD officers is listed in this newsletter. As we all know our economy is suffering and the AMFE in Anaheim will probably see lower attendance than normal. So if we can make the most of communications now, that could only help our group and the current process. Because additionally, the IFT Divisions Task Force is now up and running; they are currently reviewing/evaluating the structure and function of IFT divisions overall. This task force is currently charged to bring their recommendations to the Board of Directors in October 2009. Now is the time to address important issues in all IFT divisions to potentially make a contributing change. No one should wait until later; not this year.

Thank you,
Dallas Hoover

WELCOME LETTER TO THE DIVISION MEMBERS

Dear valued Nonthermal Processing Division member,

Thank you for joining the Nonthermal Processing Division (NPD), one of IFT's (Institute of Food Technologists') leading communities composed of scientists, technologists, engineers, students, and educators working with or interested in non-thermal technologies in processing foods. We are certain that you will find great value in your membership.

As a member of NPD, you are entitled to a variety of benefits, including:

DIVISION NEWSLETTER

All members are automatically eligible to receive the latest issue of the newsletter. The content includes a message from the Chair, recent advances in the area of nonthermal processing technologies, updates

on NPD and IFT activities, upcoming events and much more.

EMAIL & ADVANCE EVENTS ALERTS

Members will also periodically receive emails about forthcoming NPD events such as the various division symposia, workshops, meetings and activities at the IFT Annual Meeting, competitions, etc.

DIVISION INFORMATION

Members can find out about a whole host of current and past activities organized by the division by checking out the division website at <http://www.ift.org/divisions/nonthermal/>

NETWORKING OPPORTUNITIES

Membership in the Division provides a social and intellectual platform for building contacts and networking with other food industry professionals or academics working in the area of non-thermal processing of foods.

EDUCATION AND INFORMATION

Members are kept abreast of the latest technical developments in the area of nonthermal processing through relevant news articles, newsletters, fact sheets etc. available from the NPD website.

DIVISION-SPONSORED SYMPOSIA

Student members are welcomed to attend the symposia sponsored by the division at the IFT Annual Meeting. This will provide you with a great opportunity to attend presentations given by experts in the field or to discuss common pertinent problems with a diverse group of intellectuals.

JOIN IFT NPD NOW!

Food Science students, undergraduates and graduates alike, are invited to join the Nonthermal Processing Division. Division membership comes with a nominal fee of \$5 in addition to the National IFT Student Membership dues (\$50). By becoming a member of NPD, you will be eligible to receive all the benefits listed above.

INPUT TO DIVISION ACTIVITIES AND SEMINARS

1. Your input is highly desired! Become an active member of the NPD by volunteering your time to the division.
2. Alternatively, make your voice heard by submitting a short article, scientific or other, to be published in the division newsletter. Students interested in contributing articles should email the newsletter editor, Dr. Kathiravan Krishnamurthy at kkrishn2@iit.edu
3. Students are also invited to post food science, non-scientific or career guidance articles on the

NPD website. Please contact Dr. Raghu Ramasawmy (raghu.ramaswamy@avure.com) if you would like to contribute to the website.

WE WANT TO HEAR FROM YOU!

What's important to you?

The NPD has a very informative website to satisfy its readership. But the divisions needs your input to make it relevant and newsworthy. For suggestions about the website, e-mail the website editor Dr. Raghu Ramasawmy(raghu.ramaswamy@avure.com).

Also, just what should the NPD be doing to help students? Whether it be offline or online. What do you feel you need from us? What are we doing right or what could we be doing better? To share your views or if you have any comments or suggestions, email the NPD Student Representatives Mr. Rockendra Gupta at gupta.231@osu.edu or Ms. Hudaa Neetoo at hudaa@udel.edu.

We invite you to join us and participate in all Division activities. Your support and ideas are welcome and will help the Division fulfill the needs and interest of all the members.

Thank you for committing to the IFT NPD through your membership. We look forward to serving your information needs.

-Nonthermal Processing Division

NCFST RECEIVES REGULATORY ACCEPTANCE OF NOVEL FOOD STERILIZATION PROCESS

The PATS process paves the way for advanced processing of next-generation shelf-stable foods, says national research consortium

The National Center for Food Safety and Technology (NCFST), Illinois Institute of Technology (IIT) and Avure Technologies, Inc. announced today that the U.S. Food and Drug Administration (FDA) has accepted the research institute's filing of a new food sterilization process. The NCFST filing is the first ever petition to FDA for the commercial use of pressure-assisted thermal sterilization (PATS) processes for application in the production of low acid foods.

PATS is a promising new technology that significantly improves the quality of thermally processed foods while simultaneously eliminating the

food safety risks associated with dangerous bacteria such as *Clostridium botulinum* and its toxins. The novel process, which combines mild heat with high pressure to produce commercially sterile low acid food products, underwent a rigorous validation process and safety assessment by NCFST researchers and its Dual Use Science and Technology (DUST) consortium members. The seven-year multimillion dollar collaborative effort included scientists and engineers from Avure Technologies, U.S. Army Natick Soldier Research, Development and Engineering Center (RDEC), Baxter Health Care, ConAgra Foods, Hormel Foods, General Mills, Basic American Foods, Unilever, and Mars Co. The FDA's requirements for registration, manufacturing and process filing of low acid canned foods (LACF) are codified in Title 21, *Code of Federal Regulations*, Parts 108 and 113. Filers must provide extensive information regarding critical factors and processing steps that show, with a high degree of confidence, that the process used to manufacture a food will not permit the growth of microorganisms of public health significance. NCFST demonstrated that the PATS process is capable of verifiable and reproducible inactivation of *C. botulinum* spores from ambient, stable low acid foods. The NCFST team established process efficacy through an inoculated pack study using a multi-strain cocktail of *C. botulinum* spores and mashed potatoes. An Avure FP-35-600-S high pressure vessel was used in the validation study to thermally process mashed potatoes in flexible meals ready-to-eat (MRE)-type pouches.

NCFST worked closely with its process authority, Seattle, WA-based International Product Safety Consultants (IPSC), and FDA to establish validation procedures, protocols and testing for PATS and in developing the requisite reports for the LACF filing. Process validation testing began in 2006 and the application was submitted to FDA in September 2008.

"The threat of botulism makes low acid food production especially challenging for food manufacturers," says Larry Keener, DUST validation team leader and president of IPSC.

"With this FDA LACF filing, NCFST and its industry collaborators have demonstrated proof-of-process efficacy for this exciting new technology. Essentially, PATS combines a nonthermal technology, high pressure processing (HPP), which has been used successfully for many years to pasteurize a variety of refrigerated foods, including meat as well as high acid and acidified foods, with mild heat to achieve sterilization temperature. It is truly a breakthrough

process in terms of reducing the risk of *C. botulinum* contamination in these types of foods.”

The PATS process, added Keener, is a big step forward for the food industry in providing an alternative to retort processing, which involves extensive exposure of the food to high temperatures. “PATS offers food manufacturers an opportunity to provide consumers value added foods with higher nutritional content, as well. HPP has traditionally provided quality improvements in foods such as avocado, juice and some deli meats. The PATS process extends the quality improvement benefits of classical HPP with the benefit of mitigating the food safety challenge posed by *C. botulinum*.”

The successful FDA LACF filing allows NCFST to proceed with the production of demonstration products using the PATS process. Patrick Dunne, leader of the DUST consortium and senior science advisor, Department of Defense Combat Feeding Directorate of the U.S. Army Natick Soldier RDEC, which researches, develops and supports production of combat rations for the nation’s warfighters worldwide, notes that the Army greatly appreciates the combined efforts of NCFST and the industrial partners in the consortium.

“We intend to keep working with industry to extend this technology to a variety of other products that will offer major advances in the quality of shelf-stable, highly nutritious foods for our nation’s warfighters.

“The increased quality of center of the plate items and the capability to increase the variety of shelf-stable foods or ration components that we can provide our warfighters will have a positive impact on their mood, morale and performance,” says Dunne. “All new candidate rations items, such as the PATS processed mashed potatoes, are tested to be sure they retain quality over the extended shelf life we require and are tested in field exercises to be sure they are highly accepted by our warfighters. We do stress the need for both quality and safety of our combat ration items, and the PATS process provides both.”

Pat Adams, CEO of Avure Technologies, the Kent, WA-based global experts in HPP technology, says that regulatory acceptance of this innovative process is an important step for the food industry. “This technology may provide food producers with an alternative processing means that utilizes less energy and creates better-tasting products than some current offerings. Avure is developing the systems to commercialize the process with the expectation that we will further reduce the thermal requirements and enable

production of products that equal or exceed frozen foods but that can be distributed without the need of refrigeration.”

Chair of the DUST Microbiology Committee Phillip Minerich, PhD, vice president of research and development with Hormel Foods Corp., notes that the new process will have a big impact on food safety and quality assurance for the low acid foods processing sector. “Any time you can combine an innovative processing technology and food safety is a win for the consumer and industry. The PATS process produces very high quality, commercially sterile foods using a technology that has been studied for decades and is currently used as a food safety intervention for select sliced deli meats, shellfish, avocado, fruits, jams, jellies and juices.”

The National Center for Food Safety and Technology (NCFST) is a unique research consortium located at the Illinois Institute of Technology's Moffett Campus (near Chicago) in Summit-Argo, IL, composed of scientists from the FDA Center for Food Safety and Applied Nutrition (CFSAN), Illinois Institute of Technology (IIT) and the food industry. NCFST’s research addresses the food safety implications of emerging technologies in food processing and packaging and supports the development of safe food with health-promoting properties from farm to fork. For more, visit www.ncfst.iit.edu

Source: NCFST press-release

NPD MEMBERS’ CONTRIBUTION TOWARDS PATS APPROVAL



Dr. Patrick Dunne

Combat Feeding Directorate
US Army Natick Soldier RDEC

Several key members of the Nonthermal Processing Division leadership played vital roles in the consortium that accomplished the end goal of moving

the application of high pressure processing to sterilization to produce high quality shelf stable food items. This Consortium was formed in 2000 under the Department of Defense Dual Use Science and Technology program through a contract managed by Patrick Dunne of the US Army Natick Soldier RDEC with Flow International, which later became Avure Technologies with Edmund Ting as Principal Investigator. Patrick Dunne was the first Chair of the NPD and Ed Ting and Flow international were important industrial contributors to the initial workshops that have started a Division tradition. Flow/Avure built the modified 35 L high pressure processing equipment with temperature controls and placed it with prime subcontractor NCFST to setup and operate the system and to do critical basic microbiology of spores under pressure as well as identify packaging and the changes in physical properties of foods under pressure. Past Chairs of the Division Cindy Stewart and Larry Keener were instrumental in designing and implementing the biological validation for the PATS process.

PULSED ULTRAVIOLET LIGHT: AN INTRODUCTION



Dr. Katherine Bialka

Engineer, National Center for Food Safety and Technology

Pulsed ultraviolet (PUV) light is an emerging FDA approved technology with a multitude of applications within the food industry. The technology had predominately been used for curing in the production of optical discs, medical devices, and semi-conductors. But a great deal of interest has been expressed in using this technology for food applications such as the inactivation of potentially harmful microorganisms, extension of shelf-life, as well as the production of value-added products.

Pulsed UV-light utilizes more than just the

ultraviolet wavelengths, but encompasses the wavelengths of 100 to 1100 nm with the majority (~54%) within the UV range. Due to this broad spectrum light PUV-light is also referred to as; broad-spectrum white light, high intensity light, or pulsed white light (Green and others 2003). Pulsed UV-light is produced by storing electrical energy in a capacitor and releasing it in short bursts which magnifies the power.

The primary mode of inactivation is identical to that of the more commonly used UV-light. The DNA of cells exposed to UV-light (usually 254 nm) undergoes a chemical change, the formation of thymine dimers, which prevents the cell from replicating. In addition to the formation of thymine dimers it has also been proposed that there are additional modes of inactivation resulting from PUV-light; photophysical and photothermal (Krishnamurthy and others, 2007).

The efficacy of PUV-light to inactivate food related microorganisms on surfaces and in suspensions has been well documented. Rowan and others (1999) showed that reductions of almost 6 log₁₀ were possible when *E. coli*, *L. monocytogenes*, *Salmonella*, and *Staphylococcus aureus* where exposed to high content PUV-light. Anderson and others (2000) reported reductions of 8 log₁₀ of *Bacillus cereus*, *E. coli*, and *S. Enteritidis* after exposure to 1000 pulses of light.

PUV-light has also shown promise as a method of decontaminating and extending the shelf-life of foods. Milk, alfalfa sprouts, cornmeal, various vegetables, and fruits have all benefited from treatment with PUV-light in terms of pathogen reduction and/or shelf-life extension. No doubt the following articles pertaining to the cutting-edge use of PUV-light will expand on the growing list of food products successfully treated with this technology and the exciting opportunities which lie ahead.

References:

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- Krishnamurthy, K., S. Jun, J. Irudayaraj, and A. Demirci. 2007. Microscopic and spectroscopic evaluation of inactivation of *Staphylococcus aureus* by pulsed UV light and infrared heating. *Food and Bioprocess Technology*. DOI:

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PULSED LIGHT RESEARCH PROGRAM AT ALABAMA A&M UNIVERSITY



Dr. Wade Yang
Associate Professor
Alabama A&M
University



**Dr. Kathiravan
Krishnamurthy**
Postdoctoral Research
Associate (2006-2008)
Alabama A&M University

Dr. Kathiravan Krishnamurthy and Dr. Wade Yang had established a strong pulsed UV-light research program at Alabama A&M University. The main focus of our research had been in the areas of food safety and value addition using pulsed UV-light. Thus far, a Ph.D. and three master's students have graduated with their research focus on pulsed UV-light.

Our research group is the first one to investigate the application of pulsed UV-light for reduction of food allergens. Pulsed UV-light was found to effectively reduce the allergenicity of various food products such as peanuts, soybeans and milk.

Peanut allergy represents one of the most severe food allergic reactions for sensitive individuals. It has been reported that about 125 people die from peanut allergy each year in the United States. The potential of pulsed UV light to reduce the level of peanut allergens in peanut extracts and peanut butter slurry was investigated. The efficacy of PUV light treatment on the reduction of peanut allergens was examined. Raw and roasted peanut extract samples were treated for 2, 4 and 6 min in a Pulsed UV light system, Steripulse XL 3000[®]. Peanut butter slurry was treated for 1, 2 and 3 min. The distance from the central axis of the lamp was varied at 10.8, 14.6 and 18.2 cm. The SDS-PAGE showed a reduction in the band intensity for Ara h 1,

Ara h 2 and Ara h 3 at energy levels ranging from 111.6 to 223.2 J/cm². Generally, the reduction of the band intensity for peanut allergens increased with treatment time, but decreased with increased distance from the PUV lamp. The ELISA tests for peanut extracts and peanut butter slurry showed a reduction in IgE binding of up to 12.9 and 6.7 folds, respectively, compared to the controls. It was concluded that optimal allergen reduction can be achieved at longest treatment time and shortest distance from the light source, which translate into high PUV light energy levels of at least 223.2 J/cm².

More than 160 food materials are identified as allergenic and eight of them including milk lead to more than 90% of food allergies. Cow milk allergy is a major cause of transient food hypersensitivity in children. A Xenon SteriPulse-XL Sterilization System (Model RS-3000C) was used for the pulsed UV light treatment of milk proteins. The distance from PUV source was kept at 9.6, 13.2 and 17.0cm. Sodium dodecyl sulfate-polyacrylamide gel electrophoresis and enzyme linked immuno sorbent assay were used to analyze the samples. Upon PUV treatment, there were no bands of β -lactoglobulin and α -lactalbumin observed in SDS - PAGE for whey extract treated for 150s at a distance of 9.6cm. No band was appeared for α -casein when it was treated for 180s at a distance of 9.6cm from UV source. In Ci-ELISA, there was a significant difference ($p \leq 0.05$) in IgE binding values for control and treated samples. In conclusion, PUV can remove allergens from isolated milk proteins and further investigations using clinical trials need to be conducted.

Soybeans and soybean proteins are used in a variety of foods for human and animal consumption, as well as in cosmetics. However, soybean is classified as one of the big eight foods that causes food allergies. Furthermore, as the allergens are thermo-stable, traditional thermal treatments are ineffective in reducing the allergenicity of soybean. The effect of PUV on total allergen contents of soybean was investigated. Protein was extracted manually from defatted soybean seeds followed by PUV treatment for up to 4 minutes at 2.76" from the pulsed UV light source. These conditions were determined based on preliminary experiments. Following PUV treatments, extracts were analyzed using SDS-PAGE and indirect ELISA. SDS-PAGE indicated that the intensity of the protein bands decreased with an increased PUV treatment suggesting that the ingestible major allergens in soybean are reduced. This leads to reducing the severity of reactions in accidental ingestion. PUV

treatment also reduced the ELISA values compared to raw untreated soybean extract indicating the reduction of allergens. For instance, 2 and 4 min PUV treatment resulted in an optical density ELISA values of 0.05 and 0.10, respectively, indicating that total allergen content in soybean is reduced with increased PUV light treatment. Therefore, PUV treatment could be potentially used for reduction in the allergenicity of soybean for production of hypoallergenic foods and beverages.

Our research group is also interested in utilizing pulsed UV-light for effective inactivation of pathogenic microorganisms in various food materials. Effect of Pulsed UV light was evaluated on *Campylobacter jejuni* and *Salmonella* spp. suspended in 0.1% peptone water. Plating on selective media resulted in reduction from 7.75 to 3.82 log₁₀ CFU/ml after 1 s and no growth after 2 s treatment; some level of sub-lethal injury as a result of the PUV treatment was also noted. *Salmonella* was treated with PUV for treatment times ranging from one to 36 pulses. Complete inactivation was observed after 4, 10, 12, 16, and 36 pulses for sample volume size of one, two, three, four and five milliliters, respectively, when plated on Brilliant Green Agar. The effect of increased sample volume was clearly exhibited by the reduction of first order inactivation kinetic rates as the sample volumes were increased to a higher level. Liquid egg white inoculated with *S. enteritidis* was treated with pulsed UV-light alone or in combination with pulsed electric field to ascertain the presence of any synergistic effect. The log reductions ranged from 0.04 to 1.62 log₁₀ CFU/ml. No significant differences between additive log reductions for PEF and PUV individually and when treated in combination were observed, thus indicating lack of synergistic benefit.

The efficacy of pulsed UV lights in inactivating *Listeria monocytogenes* Scott A inoculated on the slices of white button mushroom (*Agaricus bisporus*) and converting ergosterol to vitamin D₂ was investigated in this study by evaluating the effects of PUV treatment times and the distance from the UV strobe. The physical quality attributes such as color, percentage weight loss and shrinkage of white button mushroom slices before and after PUV treatments were also studied. The pulsed UV sterilization system generated 1.27 J/cm²/pulse of radiant energy at 7.6 cm below the UV light strobe. The unit was operated at 3 pulses per second, with each pulse having 360 μs duration of energy emission. For vitamin D conversion, the slices of white button mushroom were placed horizontally on the shelves within the PUV chamber at a distance of 15.8 cm from

the UV strobe. Pulsed UV light treatment was performed between 10 and 120 s of radiation. The vitamin D₂ obtained at 10 s of PUV radiation was 395 μg/g DM, which was 79 times more than the recommended daily allowance of vitamin D for adults. The maximum conversion of vitamin D₂, i.e., 689.2 μg/g DM, was obtained at 100 s of radiation. For the inactivation of *Listeria monocytogenes*, 50 μL of culture solution (five spots each of 10μL) was spot inoculated on slices of white button mushroom and dried under cabinet hood for further attachment of cells. Pulsed UV light treatment was carried out at 12.0 and 14.6 cm distance for 15, 30, 45, 60, 75 and 90 s durations of exposure. A complete inactivation was achieved from the initial inoculum level of 7.481log₁₀ (CFU/g) of mushroom slice at 12.0 cm from the strobe and 45 s of exposure, or 24.6 cm from the lamp and 60 s of treatment time. Physical quality attributes such as color, shrinkage and weight losses were analyzed at 14.6 cm of distance from the PUV strobe. Beyond 45 s of treatment, a visible change in color was observed. Little change was observed in percentage weight loss up to 60 s, but after 60 s, a significant change occurred in weight loss. Mushroom samples did not show significant shrinkage until 45 s of exposure, and after 45 s, considerable shrinkage started to take place.

It is crucial to understand the contribution of temperature increase towards microbial reduction during pulsed UV light processing. Our research group was also successfully able to monitor the temperature increase in various food materials and model it.

Pulsed UV-light research team at Alabama A&M University: Dr. Kathiravan Krishnamurthy, Dr. Wade Yang, Dr. John C. Anderson, Ashutosh Singh, Nasson R. Mwakatage, Vijay A. Marry, Akshay Kumar Anugu, and Olansunmbo Ajayi.

PULSED UV-LIGHT RESEARCH AT PENN STATE UNIVERSITY

In our laboratory at Penn State, pulsed UV-light treatment have been applied for various applications in terms of operational parameters such as number of pulses, distance from UV lamp, and depth of penetration for various applications.

In order to show effectiveness of pulsed UV-light, treated *S. aureus* as suspended cells in phosphate buffer and agar seeded cells were treated by pulsed UV (Krishnamurthy et al., 2004). After a five

second treatment time, the \log_{10} reduction obtained was about 7.50 \log_{10} CFU/ml. There was no significant temperature increase during the first 5-s treatment. Though, the pulsed UV-light treatment is supposed to be non-thermal for inactivation, there was a significant increase in the temperature for longer treatment times due to the energy absorbed. During a 20 second treatment, the temperature increase was about 20°C. For agar seeded cells, *S. aureus* solution was surface plated on agar plates and the plates are treated with pulsed UV-light for up to 30 seconds. Again, a five second treatment inactivated all *S. aureus* cells. The temperature of the agar increased during long treatment times. However, there was no significant increase in the temperature during the first 5 seconds in which complete inactivation occurred. Therefore, the inactivation was mainly due to the pulsed UV-light, not due to synergistic effect of temperature increase.



Dr. Ali Demirci

Associate Professor, Penn State University

We have also studied inactivation of *S. aureus* in milk as a model to represent an opaque food (Krishna murthy et al., 2008). Milk contaminated with *S. aureus* was treated with pulsed UV-light based on the experimental design suggested by the surface response method. The reduction obtained varied from 0.16 to 8.55 \log_{10} CFU/ml demonstrating the ability of pulsed UV-light to inactivate *S. aureus*. Complete inactivation was obtained at (i) 8-cm sample distance from quartz window, 30-ml sample volume, and 180-s time combination and (ii) 10.5-cm sample distance from quartz window, 12-ml sample volume, and 180-s treatment time combination. Due to the turbidity of the milk sample, the penetration of UV-light is not effective as in the case of phosphate buffer. The reason for less penetration or less absorption of UV energy is the reflection of energy and/or absorption of energy by other milk components.

Another application of pulsed UV was on honey in which honey inoculated with of *Clostridium sporogenes* spores were treated with pulsed UV-light treatment (Hillegas and Demirci 2004). The number of pulses, the distance between honey and lamp, and depth of honey were investigated. In general, increasing the number of pulses (which also means increasing the treatment time) increased the percent reduction. The results showed an increase from 0% reduction at 15 and 135 pulses (5 and 45 seconds) to 89.4% reduction at 540 pulses (3 minutes). The percent reduction increased as the depth of honey was decreased. For instance, reductions of 0.0 and 39.5% were obtained for 8 and 2 mm honey, respectively, for a 45 sec treatment at 20 cm below the quartz window. Even though varying these three parameters enhanced the percent inactivation of *C. sporogenes*, it failed to inactivate the spores completely. It appears that the UV-light has a limited penetration in the honey. The heat generated within the Pulsed UV-light does not appear to have a synergistic effect on the inactivation of *C. sporogenes* in honey.

Pulsed UV-light system was used to inactivate fungal spores of *Aspergillus niger* in corn meal (Jun et al., 2003). Response surface methodology was utilized as the experimental design. Three parameters for the process were evaluated; processing time (20-100 sec), voltage input (2,000-3,800 V), and distance from UV lamp (3-13 cm). The voltage range of 2,000-3,800 V yielded energy output range of 1.8-5.7 J/cm² per pulse at 1.8 cm below the lamp surface. The optimal values of the three parameters based on response surface model were a treatment time of 50 sec, a sample distance of 8 cm from the UV lamp, and an input voltage of 3,800 V to yield a 3.12 \log_{10} reduction of fungal spores.

E. coli O157:H7 inoculated alfalfa seeds were treated with pulsed UV-light (Sharma and Demirci 2003). The reduction in population of *E. coli* O157:H7 for varying distances ranged from 0.07 to 4.89 \log_{10} CFU/g, with reductions being significantly higher at shorter distances and longer treatment times. Overall the germination of seeds treated at various thicknesses was not significantly reduced.

We also investigated the efficacy of pulsed UV-light to inactivate of *Escherichia coli* O157:H7 and *Listeria monocytogenes* Scott A on salmon fillets by evaluating the effects of treatment times and distance from the UV strobe Ozer and Demirci (2005). For *E. coli* O157:H7, maximum \log_{10} reduction was 1.09 \log_{10} CFU/g on muscle side at 8 cm for 60-sec treatment, whereas 0.86 \log_{10} CFU/g reduction on skin at 5 cm for 30-sec treatment. For *L. monocytogenes* Scott A,

maximum reduction was 1.02 log₁₀ CFU/g at 8 cm for 60-sec treatment on skin side, whereas 0.74 log₁₀ CFU/g reduction on muscle at 8 cm for 60-sec treatment.

We studied the inactivation of *Bacillus subtilis* spores in water by using a flow-through pulsed UV light chamber (Figure 1) (Demirci and Krishnamurthy, 2006).



Figure 1. Flow-through pulsed UV light chamber (Steripulse®-XL 4000, Xenon Corp., Xenon Corp., Wilmington, MA).

Complete inactivation (5.5 Log₁₀ CFU/ml) of *B. subtilis* spores obtained up to 14 L/min flow rates. There was no growth observed when treated samples were incubated both under light or no-light conditions, indicating that the spores were beyond repairable by both dark repair and photorepair mechanisms.

Small fruits are increasingly being implicated in outbreaks of foodborne illness, and fresh produce is now the second leading cause of foodborne illness in the U.S. We have applied pulsed UV-light treatment to strawberries and raspberries at varying UV doses and times (Bialka and Demirci, 2008). On raspberries, maximum reductions of *Escherichia coli* O157:H7 and *Salmonella* were 3.9 and 3.4 log₁₀ CFU/g at 72 and 59.2 J/cm², respectively. On the surfaces of strawberries maximum reductions were 2.1 and 2.8 log₁₀ CFU/g at 25.7 and 34.2 J/cm², respectively. There was no observable damage to the fruits at these UV doses.

Finally, we have evaluated pulsed UV-light on the microbial load of boneless chicken breast (Keklik et al., 2008). Unpackaged and vacuum-packaged samples inoculated with antibiotic resistant strain of *Salmonella* Typhimurium on the top surfaces were treated with pulsed UV-light for 5, 15, 30, 45, and 60 s at 5, 8, and 13 cm distance from the quartz window in the pulsed UV-light chamber. Log₁₀ reductions of *Salmonella*

(cfu/cm²) on unpackaged samples varied from 1.2 to 2.4 after 5-s treatment at 13 cm and 60-s treatment at 5 cm, respectively. The optimum treatment conditions were determined to be 5 cm-15 s for unpackaged samples and 5 cm-30 s for vacuum-packaged samples, both of which resulted in about 2 log₁₀ reduction (~99%). We have recently designed and built a pilot-scale continuous pulsed UV-light system for decontamination of whole chicken carcasses (Figure 2). We are currently working on the system's performance.



Figure 2. Pilot-scale continuous pulsed UV-light system for decontamination of chicken carcasses.

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PULSED UV-LIGHT RESEARCH AT CORNELL UNIVERSITY



Dr. Carmen Moraru

Assistant professor, Cornell University

Dr. Carmen Moraru's research group at Cornell University has been doing research in the area of Pulsed Light since 2003. Their work led to a better understanding of the potential, as well as the limitations of Pulsed Light treatment as an intervention strategy for the control of pathogenic microorganisms in foods. Using model systems, they elucidated how surface characteristics such as topography and optical properties affect the degree of microbial inactivation on surfaces. They also demonstrated that the main contributor to microbial inactivation by Pulsed Light treatment is the low wavelength – high intensity ultraviolet portion of the electromagnetic spectrum and

have developed kinetic models to quantitatively describe the Pulsed Light inactivation of *Listeria* and *E. coli* as a function of treatment dose.

Another component of their Pulsed Light research focused on identifying feasible practical applications of Pulsed Light. By performing treatments under turbulence, they were able to achieve the FDA required 5-log reduction of *E. coli* O157:H7 in apple juice and cider, without heating and without noticeable effects on the sensory attributes. Recently, they started exploring the potential of Pulsed Light treatment to be used as part of a hurdle process to control post-process contamination with *Listeria* in ready-to-eat meats. They are currently working on developing Pulsed Light treatments that can be applied through transparent packaging materials, which would be a unique terminal safety assurance step for ready-to-eat food products. A new exciting direction of research in Dr. Moraru's group consists in using Pulsed Light treatment for improving the barrier properties of protein films by crosslinking.

So far, three graduate students earned their MS degree, and three graduate students are currently pursuing their PhD degrees in the area of Pulsed Light research. Five undergraduate students have also conducted Pulsed Light research as part of the group. All graduate students performing Pulsed Light research in Dr. Moraru's group have earned recognition in the graduate student paper competitions of the Nonthermal Division of IFT.

Dr. Moraru and her group frequently serve as a resource for food companies interested in alternative methods to increase the safety and shelf life of their products. Funding for Pulsed Light research at Cornell has been supported by funds from USDA, Cornell University Agricultural Experiment Station and the Food Industry.



Figure 1: Aaron Uesugi setting up for fluence measurements using RS-3000C Steri Pulse System from Xenon Corporation (Woburn, MA).

Research group: Dr. Carmen I. Moraru, Marissa Agustin (undergraduate student, Biological Engineering), Lillian Hsu (PhD student), Aaron Uesugi (PhD student) and Daina Ringus (PhD student)

Representative publications in the area of Pulsed Light from our group

Peer reviewed articles:

Uesugi A. and Moraru C.I. 2009. Reduction of *Listeria* on ready-to-eat sausages after exposure to a combination of Pulsed Light and nisin. *Journal of Food Protection* 72(2):347-353

Sauer A. and Moraru C.I. 2009. Inactivation of *E. coli* ATCC 25922 and *E. coli* O157:H7 in apple juice and apple cider using Pulsed Light treatment. *In press. Journal of Food Protection*

Uesugi A., Woodling S.E. and Moraru C.I. 2007. Inactivation kinetics and factors of variability in the Pulsed Light treatment of *Listeria innocua* cells. *Journal of Food Protection* 70(11):2518-2525

Woodling S.E. and Moraru C.I. 2007. Effect of spectral range in surface inactivation of *Listeria innocua* using broad spectrum Pulsed Light. *Journal of Food Protection* 70(4):906-916

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Book chapter:

Moraru C.I. and Uesugi A. 2009. Pulsed Light Treatment: Principles and Applications. In: *Ultraviolet Light in Food Technology: Principles and Applications*, by Koutchma T., Forney L. and Moraru C.I. pp. 235-265. *In press.*

Proceedings:

Moraru C. I., Uesugi A. R., Woodling S. E. and Sauer A. 2007. Microbial inactivation in foods using Pulsed Light: Factors of influence and potential applications. *Proceedings of the 2007 World Congress on Ozone and Ultraviolet Technologies*. P. 2738-2754

Woodling S.E. and Moraru C.I. 2005. Pulsed Light inactivation of *Listeria innocua* on solid surfaces – substrate and spectral range effects. *Proceedings of the 9th Conference of Food Engineering*

CURRENT RESEARCH ON PULSED LIGHT TREATMENTS AT UNIVERSITY OF LLEIDA, SPAIN



Dr. Olga Martín-Belloso
University of Lleida, Spain

In-depth research on pulsed light technology is being conducted by the research group of New Food Processing Technologies (University of Lleida, Spain), led by Dr. Olga Martín-Belloso. During the last couple of decades, the group has been working on different emerging technologies that may help to process plant-based foods while maintaining their fresh properties. Special attention has been drawn to the development of minimally processed products, for instance fresh-cut fruits and vegetables. The market for fresh-cut commodities has undergone a fast growth within the last decade. However, there are still some concerns about the safety of these products, as no effective methods to reduce microbiological contamination are available for processors. Therefore, the application of physical preservation techniques such as pulsed light could be an alternative to reduce the surface contamination of fresh-cut products.



Figure 1. Pulsed UV-light equipment at University of Lleida, Spain

An ongoing project is currently aiming at evaluating the effects of PL treatments on different quality aspects of fresh-cut edible fruits and mushrooms, including microbiological and physiological stability, enzymatic activities, organoleptical properties, as well as nutritional characteristics. A lab-scale system delivering a fluence of 0.8 J/cm^2 per pulse is used to apply different radiation doses to the products. To date, significant microbial reductions in fresh-cut watermelon and a rapid disinfection of fresh-cut mushrooms without affecting the overall quality of the product are some of the most outstanding benefits identified. In addition, the color and the texture of these products seem to be better maintained in comparison to non-treated samples. In addition, there are some promising results supporting the claim that PL can help to better maintain the nutritional value of fresh-cut products. The low energy costs, the lack of residual compounds as well as the easiness and flexibility of application are other of the advantages of the technology.

Involved reseachers: Robert Soliva-Fortuny, Olga Martín-Belloso, Pedro Elez-Martínez, M Alejandra Rojas-Graü, Ingrid Aguiló-Aguayo

For further information contact Dr. Robert Soliva-Fortuny at rsoliva@tecal.udl.cat.

INACTIVATION PROFILES OF *LISTERIA MONOCYTOGENES* USING PULSED ULTRA VIOLET LIGHT

Allison Pollock¹, Michael Ngadi^{2*} and Hosahalli S. Ramaswamy¹

¹Department of Food Science and ²Department of Bioresource Engineering, McGill University



Dr. Michael Ngadi

Associate professor, McGill University

Introduction

Pulsed light (PL) technology has been applied successfully in sterilizing or reducing microbial populations on the surface of packaging materials, transparent pharmaceutical products, or other surfaces (Dunn *et al.*, 1997b). At McGill University, the technology has been evaluated for fruit juices and food processing water (Ngadi *et al.* 2003; Ngadi *et al.* 2004) as well as for fish products (Pollock *et al.* 2006a,b).

The effectiveness of a pulsed UV treatment system depends on several factors related to the equipment, process, product and target microorganism. It is vital that these factors are standardized prior to application of the technology. In particular, the intensity of a light and its effect depends on its initial power of the source and distance of the target from it. Thus, before embarking on any destruction kinetics and challenge studies it is critical to characterize the pulsed light system and treatment conditions.

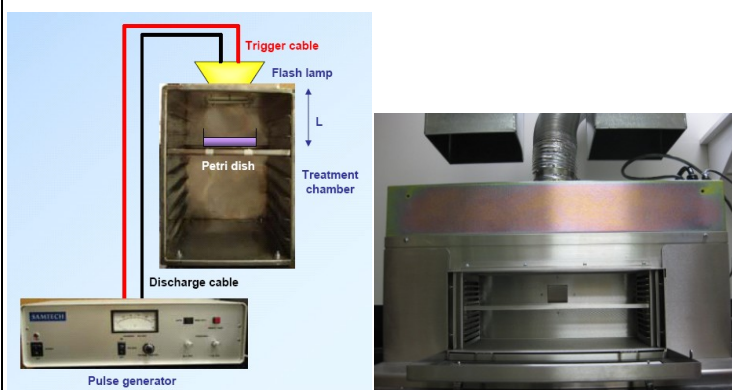


Figure 1: Pulsed light equipment units at McGill University. a) Modular unit with a pulse generator and b) High power Xenon SteriPulse®-XL 3000 unit.

There has been concern about the safety of products such as vacuum packed (VP) smoked cold salmon stored at refrigerated temperatures, specifically with respect to the growth of *L. monocytogenes* (FDA, 2001; Huss *et al.*, 1995). Refrigerated storage alone cannot be regarded as an adequate safety barrier and additional barriers are needed to ensure the continued safety of VP smoked fish products. Pulsed light as a non-thermal technology can be a novel processing barrier to preserve the quality and safety of cold packaged products. The objective of this paper was to show temperature profiles inside a pulsed light treatment chamber, qualitatively examine the resistance of 5 strains of *Listeria monocytogenes* to UV inactivation, and evaluate potential of using pulsed light

as a post packaging treatment for vacuum packed cold smoked salmon.

Methods and Materials

PL treatments were delivered with varying treatment times, voltage levels and distance from the flash lamp. Temperature at different locations was monitored with reversible temperature labels (Multi Temp Liquid Crystal Strips, models RLC series 60, OMEGA Engineering Inc., Stamford, CT, USA) placed on top and beside samples. Five strains of *Listeria monocytogenes* namely HPB strains Scott A (smoked salmon isolate), 323 (shrimp isolate), 392 (lobster isolate), 439 (crab isolate) and 976 (smoked salmon isolate) were inoculated either on agar or cold smoked salmon surfaces. Standard methods were used to culture and enumerate the cells.

Results and Discussion

UV light distribution in the treatment chamber was varied at different distances from the flash lamp (Figure 2).

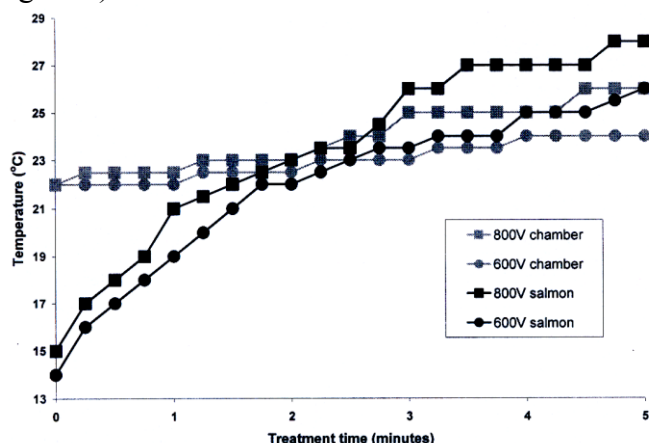


Figure 2: Distribution of UV at different distances (5, 10 and 15 cm) from the flash lamp in a pulsed UV light treatment chamber. The box shows effective inactivation area.

The percent surface area exposed (and effective for microbial inactivation) increased as the distance from the flash lamp was increased. Thus, it is vital to consider sample surface area, distance from the lamp and the effective coverage of the light irradiation in any UV light process design. Figure 3 shows temperature profiles in a treatment chamber during a 5 min treatment period. Air temperature in the chamber increased from 22°C to either 24 or 26°C when the voltage of the pulse generator was 600 or 800 V, respectively. For smoked salmon, final temperatures were 26 and 28°C with voltages of 600 and 800 V, respectively.

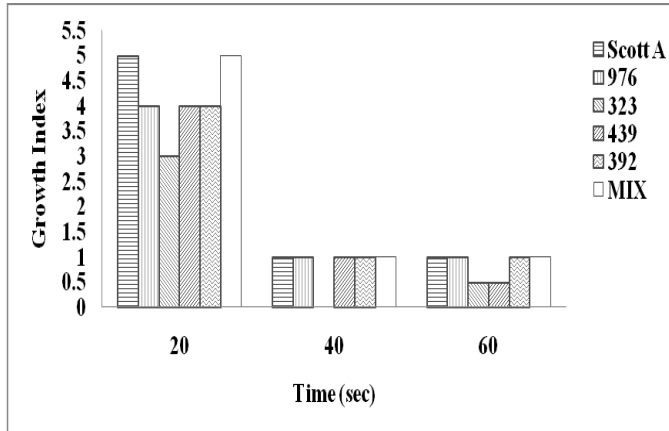


Figure 3: Temperature profiles in pulsed UV treatment chamber for air and surface of vacuum packed cold smoked salmon samples. UV light was generated using 600 and 800 V.

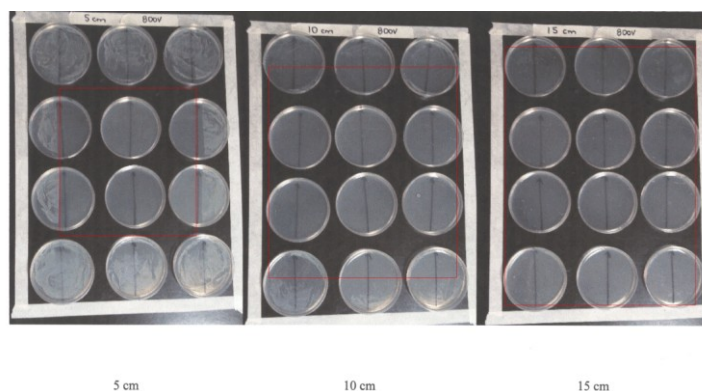


Figure 4: Qualitative resistances of 5 strains and mixed cultures of *L. monocytogenes* isolated from marine sources during pulsed UV treatment (660 V and 15 cm from flash lamp). The growth indices are 0 (no growth), 1 (light growth), 2 (Medium, countable growth), 3 (heavy, countable growth), 4 (extensive growth, distinct colonies) and 5 (lawn growth).

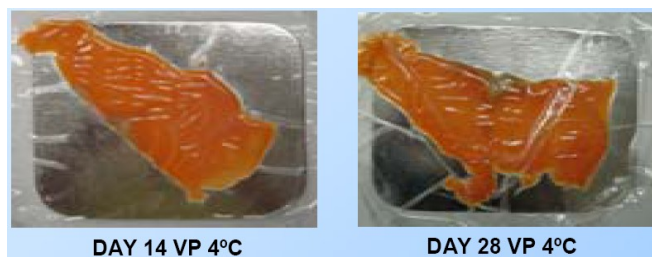


Figure 5: Inoculated vacuum packed pulsed light treated cold smoked salmon slices after 14 and 28 days storage at 4°C.

Considering that typical smoking temperatures are below 30°C, the increase in temperature during PL will not affect quality of the product. Temperature increased with increasing power supply to the pulse generator. Up to 85°C temperature increase has been

reported with higher pulse power (Ozer and Demirci, 2004). Among the strains tested, *L. monocytogenes* strain Scott A was generally more or as resistant as the other strains whereas the strain 323 was less resistant (Figure 4). As expected, there was minimal drop in cell concentrations after 20 s treatment. There was no change in the quality of pulsed UV treated VP cold smoked salmon samples stored at 4°C for 14 days (Figure 5). However, at 12°C storage temperature, marked change in quality was observed after 14 days. Pulsed light in combination with low temperature storage has potential to be used as a post-packaging barrier to extend the shelf-life of VP cold smoked salmon without compromising quality.

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SQUEEZING SEEDS LEADS TO SAFER SPROUTS



Ms. Hudaa Neetoo

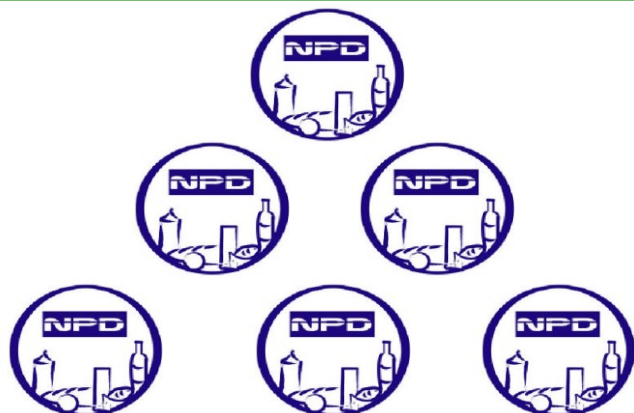
Ph.D. candidate, University of Delaware

In many countries worldwide, the consumption of seed sprouts has increased in recent decades with the advent of nutraceuticals, phytochemicals (Shetty et al., 2003) and the shift of consumer preference towards health foods (Gabriel, 2005).

Alfalfa sprouts are one of the most common sprouts consumed in the United States due to availability and nutritional value (Fett et al., 2005). Alfalfa, also known as lucerne in other parts of the world, originated in Armenia and its name in Arabic means “Alf-al-fa”, “Father of all foods.” (Meyerowitz, 1999). Alfalfa as grown in the field, has a great diversity of vitamins and minerals. Besides the excellent nutritional profile of alfalfa sprouts, their impressive prophylactic ability against various types of diseases including cancers, cardiovascular diseases, diabetes amongst others are being confirmed by recent research worldwide (Fett, 2005).

Unfortunately, the germination process of seeds to sprouts makes this commodity susceptible to microbial contamination and growth, thereby compromising the safety and quality of the final product (Gabriel, 2005). As a matter of fact, there have been recurrent outbreaks in the past decade implicating sprouts and foodborne pathogens such as *Salmonella* and *E. coli* O157.

This has thus triggered a lot of research in that direction focusing mainly on seed decontamination. However, most of the intervention technologies investigated so far, whether physical, chemical or biological, have been reported with varying degrees of efficacy. The treatments either could not completely kill



the pathogens on the seeds or the treatment would compromise the seed viability.

This food safety issue, also seemingly trivial, actually holds great relevance. A lot of people really like to eat sprouts, either in salads or sandwiches. Since consumers insist on eating their sprouts raw, science must find an alternative method to inactivate those bacteria. There is an alternative and that is high pressure treatment.

Haiqiang Chen, a research scientist at the University of Delaware, has decided to look at the treatment of sprouting seeds such as alfalfa and mung bean seeds under pressure. With non-thermal processing technologies such as high hydrostatic pressure technology, more fresh-like products can be guaranteed unlike conventional thermal processes such as cooking. The other advantage of high pressure for decontaminating sprouting seeds over other treatments especially lies in the fact that it is a green-technology and therefore chemical free. Studies done in Chen's lab have shown that it is possible to completely kill pathogenic bacteria such as *E. coli* O157:H7 and *Salmonella* on alfalfa seeds using high pressure with minimal negative impact on the seeds.

Although it is estimated that the price of pressure treated products is still a bit higher than foods treated in a more conventional way, high pressure holds great promise and it is probably a matter of time before this technology becomes adopted by the seed industry.

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Dr. PAT DUNNE RECEIVES OUTSTANDING VOLUNTEER AWARD



Please join us in congratulating Dr. Pat Dunne, the recipient of our 2009 outstanding volunteer award. Dr. Dunne made significant contributions to the division and served as the first chair of the non-thermal division. Congratulations Dr. Dunne!

Dr. C. Patrick Dunne has a Ph.D. in Biochemistry from Brandeis University and a B.A. in Chemistry from the University of California at Riverside. Before coming to the U.S. Army Research Center in Natick, MA in 1979, Dr. Dunne was on the faculty at the University of Detroit and California State University at Long Beach; he also was a postdoctoral associate in biochemistry at Michigan State University.

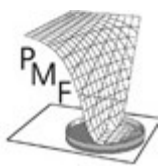
Dr. Dunne is the Senior Advisor in Advanced Processing and Nutritional Biochemistry for the DoD Combat Feeding Directorate of the U.S. Army Natick Soldier RD & E Center of the Army RDE Command. Since 1991 he has led the Advanced Preservation Project at Natick and has taken a lead role in Dual Use Science and Technology projects in advanced food processing technologies. Dr. Dunne is co-author of several research papers on nonthermal food processing technologies. His research efforts in food biochemistry and nutritional biochemistry support the development of improved rations for the military. Dr. Dunne was a founding member of the new Nonthermal Processing Division of IFT; he was elected the first Chair of that Division in 1999. Dr. Dunne received a Federal Laboratory Consortium Award for Excellence in Technology Transfer in 2005 and was the IFT Myron Solberg Award winner for 2005. He was named as an IFT Fellow in 2009.

REQUEST FOR CONTRIBUTIONS

Please send your contributions (profile of research programs, research updates, announcements, etc.) to Dr. Kathiravan Krishnamurthy (kkkrishn2@iit.edu) by **August 1, 2009** to be included in the next issue of NPD Newsletter. If you have any questions regarding the appropriateness of items for the newsletter or if you wish to make any comments regarding the current issue, please contact the editor.

We will be focusing on **ULTRASOUND PROCESSING** in the upcoming newsletter.

6TH INTERNATIONAL CONFERENCE ON PREDICTIVE MODELING IN FOODS



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INTERNATIONAL FORUM ON EMERGING TECHNOLOGIES IN FOOD PROCESSING

September 23 – 25, 2009

This is an invitation to the IFT Nonthermal Processing Division members to attend a symposium we have organized (see attached flyer) on Emerging Technologies in Food Processing at the University of Illinois in Urbana for the fall, 2009 semester (September 23-25; http://fshn.illinois.edu/food_processing_forum). There is no charge for registration for the meeting for university staff and students, although there is a modest charge (\$50) for industry personnel. Seating is limited. There will be poster presentations at the meeting, so if anyone in your department would like to present a poster on their research we would welcome that. Submission information is listed below.

Your presentation will be on Friday (September 25) at 9:30 am. I'll be sending additional information to each speaker regarding their hotel reservation, airline reservation, etc. soon. I've made the hotel reservations for all the speakers and I'll make the airline reservations in early August, once everyone informs me of their home airport and when they intend to leave and return. If you have any questions, concerns, etc. please contact me at 333-9337 or wartz@illinois.edu.

- Dr. Willima Artz

From Wednesday evening, September 23 to Friday, September 25, 2009 the Department of Food Science and Human Nutrition (FSHN) at the University of Illinois, Urbana-Champaign (UIUC) will host an International Conference on "Emerging Technologies in Food Processing." New methods of food processing are needed to produce safe food products that have better sensory and nutritional quality than the traditional thermal canning/pasteurization processes. This international conference will offer a two and half day forum at the University of Illinois in Urbana, Illinois to address research on the emerging technologies in this important area of food safety and security. This symposium will provide a platform to update the R&D sector about the progress in emerging food processing technologies and will explore potential applications of the technologies to a diverse group of food products. Information on the symposium program (speakers and presentation titles), as well as meeting registration and hotel information, is available at:

http://fshn.illinois.edu/food_processing_forum/

To submit a research poster for the poster session, please submit a title and a short abstract (~100 to 200 words) to Dr. Youngsoo Lee at leeys@illinois.edu

For more information, please contact Dr. Hao Feng at haofeng@illinois.edu (217-244-2571) or Dr. William Artz at wartz@illinois.edu (217-333-9337)

2009 BEIJING INTERNATIONAL CONFERENCE ON NON-THERMAL PROCESSING TECHNOLOGIES

Non-thermal food processing technologies, including high hydrostatic pressure, pulsed electric fields, high pressure carbon dioxide, gamma irradiation and cold plasma, etc., are innovation technologies employed in food processing, mainly used to inactivate food-borne microorganisms and enzymes. Unlike thermal processing, non-thermal technologies minimally affect the color, aroma, flavor, functional and nutritional components of food stuff, especially the thermo-sensitive food, so that the products can be quality guaranteed while being kept fresh. In recent years, consumer demands for the freshness, nutrition, safety and function of food have risen with the increasing consumption level, which to a large extent promoted the world-wide study and development of the non-thermal food processing technologies. Some of the technologies like high hydrostatic pressure have already been commercialized in some developed countries such as USA, Japan and France. Furthermore, through expanded researches, the application of these novel technologies has been extended to the extraction of food functional components, modification of properties of macromolecules, and so on. Aiming at facilitating the development and progress of these novel technologies, promoting the communication between international industry and academia, and defining future research directions in non-thermal technologies, 2009 Beijing International Workshop on Non-thermal Processing Technologies will be held in Beijing from October 13 to 16, 2009, with the joint efforts from CIFST, IFT and EFFoST.

The theme of the Conference is “Non-thermal technologies for safety, quality and functionality of food”. International authorities from Europe, USA and Japan will introduce the latest progresses in non-thermal food processing technologies. People from world-leading enterprises will also be invited to

present the commercial application of non-thermal technologies in food production. We have set forth the goals of providing an opportunity and an exchange platform for scientists, engineers and technologists from industry, academia and government to obtain a better knowledge of the emerging non-thermal food processing technologies.

Organizers:

Chinese Institute of Food Science & Technology
Institute of Food Technologists
European Federation of Food Science & Technology

Date and Venue

Date: October 13-16, 2009.

Venue: Jinma Hotel

Address: Qinghua East Road No 17, China
Agricultural University, Haidian District, Beijing, China.

TEL: +86 (0) 010-62428899

Program

Tuesday, October 13

08:00—9:00 Short course - onsite registration
09:00—12:00 Non-thermal processing technology short course
09:00—12:00 Workshop - onsite registration
13:00—17:30 Opening ceremony and Workshop Sessions

Wednesday, October 14

08:00—17:00 Workshop Sessions
19:00—22:00 Workshop Dinner

Thursday, October 15

08:00—17:00 Workshop Sessions

Friday, October 16

09:00—17:00 Technical Visits

2009-2010 NPD EXECUTIVE COMMITTEE ELECTION RESULTS

Please join us in congratulating our newly elected “executive committee” officials for 2009-2010.

Chair elect

Dr. VM (Bala) Balasubramaniam

Secretary

Dr. Chris Doona

Member-at-large

Dr. Elaine Black
Dr. Stefan Toepfl

NONTHERMAL PROCESSING DIVISION

**Schedule of events at IFT Annual Meeting & Food Expo
Anaheim, CA (June 6 to 9, 2009)**

Time	NPD (Primary Sponsor)	NPD (Secondary Sponsor)
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Sunday June 07, 2009

8:15am -9:45am	ORAL SESSION 014. Effects of nonthermal processes on fruit and vegetables: Part 1 Room 207C	
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Reception

10 YEAR ANNIVERSARY OF THE NONTHERMAL PROCESSING DIVISION

Venue: PopTheCork (321 W. Katella Ave, Anaheim)
Time: 7:00 to 9:00 PM

Monday June 08, 2009

8:30am - 10:00am	SYMPOSIUM 091. Innovation in multiphysics modeling of emerging food processing technologies, Part 1: Pulsed electric field and high-pressure processing Room 203AB	SYMPOSIUM 081. Emerging technologies in dairy foods: From microbial inactivation to novel functionality Room 202AB
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10:30am - 12:00pm	SYMPOSIUM 107. Innovation in multiphysics modeling of emerging food processing technologies, Part 2: Ultraviolet, ultrasound and cool plasma processing Room 203AB	
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Monday June 08, 2009

11.00am-11.45	Pressure Assisted Thermal Sterilization (PATS) Press Conference Room 213C	
11:00am - 1:30pm	POSTER SESSION 125. Nonthermal Processing Division Hall A	
1:30pm - 3:00pm	ORAL SESSION 141. Nonthermal Division lecturer and technical research presentations Room 210D	
2:30pm - 5:00pm	POSTER SESSION 156. Nonthermal Processing Division Hall A	

Tuesday June 09, 2009

8:30am - 10:00am	SYMPOSIUM 192. Novel processing technologies for food structure modification Room 203AB	
10:30am - 12:00pm	SYMPOSIUM 223. A 10-year retrospective: Celebrating the accomplishments of the Nonthermal Processing Division Room 203AB	SYMPOSIUM 219. Irradiation of fresh produce: Commercial application Room 207A
12:00pm - 2:00pm Lunch meeting	EXECUTIVE COMMITTEE MEETING EX23. Nonthermal Processing Division Open Executive Committee	
1:15pm - 2:45pm	ORAL SESSION 243. Effects of nonthermal processes on fruit and vegetables: Part 2	PANEL DISCUSSION 238. Survey of emerging applications for low voltage electron beam technology Room 207D

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