

United States Department of Agriculture • Agricultural Research Service
Poultry Production & Product Safety Research Unit

Highlights

and REPORT
for 2007

GETTING TO THE HEART OF OUR RESEARCH: IMPROVING QUALITY IN POULTRY PRODUCTION AND REDUCING PROBLEMS FOR THE INDUSTRY



DR. ANN DONOGHUE, RESEARCH UNIT LEADER IS SHOWN CONDUCTING AN EXPERIMENT INVOLVING TURKEY POULTS AND BACTERIA.

The ARS Poultry Production and Product Safety Research Unit in Fayetteville is in its 16th year and continues its innovative research program within the Center of Excellence in Poultry Science at the University of Arkansas. We appreciate the scientific collaboration of university faculty, national and international scientists, local, state and national agencies and industry partners.

In 2007, our scientists received 2 national awards, gave 6 international invited scientific presentations, published 21 peer-reviewed scientific manuscripts or book chapters, 17 proceedings papers, technical reports or abstracts and submitted 3 patents. We were pleased to host visiting professor Dr. In Hag Choi from Daegu University in South Korea working with Dr. Moore on solutions for phosphorus utilization from poultry litter. We congratulate Vik Dutta who finished his Masters Program working with Dr. Gerry Huff on investigating the food borne pathogen *Listeria monocytogenes* in an effort to improve food safety strategies. This annual review highlights our scientific efforts for 2007. Thanks again to all our collaborators and we look forward to new and continuing partnerships for the coming year.

Annie Donoghue, Research Leader



ACCOMPLISHMENTS/IMPACT 2007 AWARDS



DR. GUILLERMO TELLEZ, RESEARCH SCIENTIST, IS A MEMBER OF THE RESEARCH TEAM THAT RECEIVED THE OUTSTANDING TECHNOLOGY TRANSFER AWARD IN 2007.

National Excellence in Technology Transfer Award from the Federal Laboratory Consortium awarded to Dr. Annie Donoghue, Research Leader and University of Arkansas collaborators Dr. Billy Hargis, Dr. Dan Donoghue and Dr. Guillermo Tellez for development of a novel method of identifying beneficial bacteria that when fed to poultry out compete enteric food borne pathogens substantially reducing the risk of human food borne contamination and improving the health of poultry.

2007 Agricultural Research Service, Outstanding Technology Transfer Award to the research team Dr. Annie Donoghue, Research Leader and University of Arkansas collaborators Dr. Billy Hargis, Dr. Dan Donoghue and Dr. Guillermo Tellez for development of a novel probiotic for poultry.

SCIENTIFIC INNOVATIONS

Patented an ammonia scrubber for poultry houses: Ammonia emissions from animal rearing facilities may negatively impact air quality. Scientists from our unit patented an ammonia scrubber that removes ammonia and dust from air exhausted from poultry facilities. This system utilizes a dilute alum solution to capture ammonia nitrogen which would otherwise be lost to the atmosphere. This nitrogen can be utilized by the farmer to grow crops. The aluminum in the solution has the added benefit of reducing soluble phosphorus in soils, which will reduce phosphorus runoff. ARS is licensing this technology to General Chemical Corp.

Discovered phosphorus runoff from biosolids could be reduced using water treatment residuals: Phosphorus runoff from biosolids (sewage sludge) negatively impacts water quality. As a result, over half of the biosolids produced in the U.S. are burned or placed in landfills. Scientists from our unit developed and tested a new best management practice that helps eliminate this problem. Research demonstrates that when waste water from drinking water plants known as water treatment residuals (WTRs), such as alum sludge, are added to biosolids it results in significantly lower phosphorus runoff, creating an environmentally friendly fertilizer. Initial calculations indicate that there are enough WTRs to treat all of the biosolids produced in the U.S. Hence, this technology could change the way biosolids are handled in this country and could potential save taxpayers several hundred million dollars per year in landfill fees.

DEVELOPING ALTERNATIVE APPROACHES TO ANTIBIOTICS FOR CONTROLLING DISEASES

Completed a three year study on ammonia emissions: Ammonia emissions were measured from broiler litter in four tunnel-ventilated houses and following land application. A nitrogen mass balance study was also conducted. Alum treatments (aluminum sulfate, a soil amendment discovered by unit scientists to reduce ammonia emissions and phosphorus runoff) significantly reduced ammonia concentrations and emissions for the first 3-4 weeks of each flock. Dry alum was more effective than liquid alum in reducing emissions. Ammonia losses from poultry litter following land application totaled 15% of the total nitrogen applied, when the litter was broadcast applied onto pastures. However, when litter was incorporated into pastures, ammonia losses were virtually zero.

Revised the Arkansas Phosphorus Index: Scientists from our unit conducted 432 rainfall simulations to determine the amount of phosphorus runoff from biosolids, poultry litter, swine manure, dairy manure and commercial fertilizers. These data, in conjunction with long-term runoff data from small watersheds, is being used to revise and validate the Arkansas P index (a risk assessment tool used to determine how much phosphorus can be applied on a given field). Scientists from our unit also organized the Arkansas Phosphorus Index Advisory Panel; a group of 42 experts from 14 organizations in Arkansas, including University of Arkansas faculty and all of the agencies responsible for management of natural resources within the state. This panel and its sub-committees met 16 times during the past year to help revise the Arkansas Phosphorus Index. The final revisions are currently being made to the index. This research was supported by funding from the U.S. Environmental Protection Agency, the Arkansas Natural Resources Commission and USDA/ARS. The impact of this work is enormous since this index determines how much P fertilizer or manure can be applied to the fields of Arkansas.

Investigating *Listeria monocytogenes* in Poultry: Infections account for the highest hospitalization rates (91%) among known foodborne pathogens and affect approximately 2500 Americans annually. *L. monocytogenes* contamination of turkey processing plants and ready-to-eat products is of critical concern to the FSIS, USDA. Unit research proposed a novel hypothesis to account for the distribution of persistent strains of *L. monocytogenes* in meat processing environments and provided new critical control points within the plant for elimination of this problem. This research also suggests that feed supplementation with yeast extract can modify the stress response of turkeys, potentially leading to improved resistance to infection with opportunistic bacterial pathogens.

Bacteriophage for Fighting Disease: Scientists in the unit are leaders in establishing that bacteriophage (viruses that infect and kill bacteria) can provide an effective alternative to antibiotics in animal production to both prevent and treat animal bacterial diseases. This research is critically important to the animal industry seeking alternatives to antibiotics and has provided an animal model to evaluate the efficacy of bacteriophage in veterinary and human medicine. Research has continued this year with our CRADA partners BioDetection Instruments and the Arkansas State Diagnostic Laboratory. The Arkansas State Diagnostic Laboratory has provided over 40 isolates of *E. coli* that have been used to discover bacteriophage active against these isolates. This work is the first phase in the process to develop a bacteriophage product to prevent and lessen the impact of colibacillosis to the poultry industry.

INVITED PRESENTATIONS AND SPECIAL ASSIGNMENTS



AGRICULTURAL RESEARCH SERVICE (ARS) BIOLOGICAL SCIENCE TECHNICIAN SCOTT ZORNES LETS POULTS OUT OF A CHAMBER AFTER THEY INHALED AN AEROSOL MIST CONTAINING BACTERIOPHAGES. THE MIST HAS PROVEN TO BE AN EFFECTIVE MEANS OF ADMINISTERING BACTERIOPHAGE TREATMENTS TO PROTECT

Presentations:

Dr. Narayan Rath, Physiologist, presented “Antimicrobial and other small peptides of immunological interest in heterophils and macrophages” at the annual Technical Committee Meeting of NE-1016, Genetic Basis for Resistance and Immunity to Avian Diseases at the Ontario Veterinary College, University of Guelph, Guelph, Ontario, Canada.

Dr. Narayan Rath, presented “Thymosin beta in macrophages” at the Society for Reproductive Biology and Comparative Endocrinology, Trivandrum, India.

Dr. Philip Moore, Soil Scientist, presented “Long-Term Effects of Poultry Litter, Alum-Treated Litter and Commercial Fertilizer on Soil Chemical Properties and Phosphorus Runoff” at the Midwest Poultry Federation that was held at St. Paul, Minnesota.

Dr. Geraldine Huff, Microbiologist, presented “Stress, wet litter, and colibacillosis” at the 1st Turkey Science and Production Conference in Macclesfield, UK.

Dr. Geraldine Huff, presented “Effects of a dietary yeast extract on hematological parameters, heterophil functions, and bacterial clearance in turkey poults” at the XVIth European Symposium on Poultry Nutrition in Strasbourg, France.

Dr. Annie Donoghue, Research Leader, collaborated on “Mannan-oligosaccharide yeast extract supplementation enhances early gut development in turkey poults” at the XVIth European Symposium on Poultry Nutrition. (graduate student, Fausto Solis de los Santos presented the research).

Dr. Annie Donoghue, collaborated on “Caprylic acid as a dietary supplement has therapeutic efficacy against enteric *Campylobacter jejuni* in chickens at the 14th International Workshop on *Campylobacter*, *Helicobacter* and Related Organisms. Rotterdam. (graduate student, Fausto Solis de los Santos presented the research).

USDA-ARS/POULTRY PRODUCTION AND PRODUCT SAFETY RESEARCH UNIT HIGHLIGHTS CONTINUED



WORKING TOGETHER AS A TEAM IS IMPORTANT TO THE PPPRSU. HERE SEVERAL MEMBERS OF THE UNIT AND UNIVERSITY COLLABORATORS ARE SHOWN WORKING ON A RESEARCH PROJECT. THIS COLLEAGIAL ATMOSPHERE HAS LED TO SEVERAL AWARDS, HONORS AND ASSIGNMENTS AS YOU SEE LISTED IN THIS REPORT

Special Assignments:

Dr. Geraldine Huff, participated in the Food Safety Inspection Service Turkey Correlation. “Green liver-turkey osteomyelitis complex: are there food safety implications,” Fayetteville, AR.

Dr. Geraldine Huff collaborated with Australian researcher, Dr. Shaniko Shini, in submission of a grant proposal titled “Role of gut-derived bacterial endotoxin in broiler heat stress mortality” to the Rural Industries Research and Development Corporation (RIRDC), Australia.

Dr. Philip Moore served as the USDA/ARS appointee on the Arkansas Watershed Advisory Group.

Dr. Philip Moore served on the United Egg Producer’s Environmental Scientific Panel.

Dr. Philip Moore actively participated on the Phosphorus Index Revision Team to the Arkansas P Index Advisory Panel.

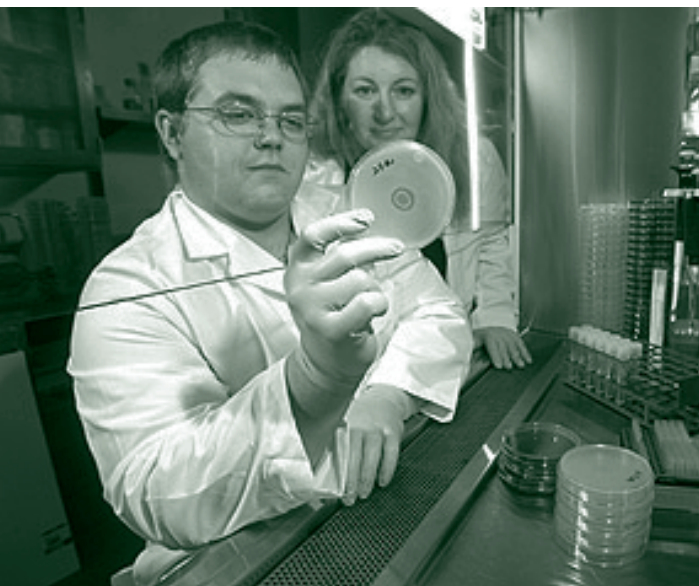
Dr. Philip Moore gave an overview of our research on mixing sewage sludge with water treatment residuals to the SERA-17 group.

Dr. Philip Moore was an invited expert for the Knowledge Gap Assessment - a panel discussion in Fayetteville, AR on August 3, 2007 sponsored by the Beaver Water District.

Dr. Philip Moore gave an invited talk in Eureka Springs to the Arkansas Nutrient Management Advisory Committee on expected changes to nutrient management planning in Arkansas.

Dr. Philip Moore met with Dr. Mark Dunlap, a visiting scientist from Australia, on methods developed to reduce ammonia emissions from animal manure such as treating litter with alum and the development of an ammonia scrubber.

MEMBERS OF THE POULTRY PRODUCTION AND PRODUCT SAFETY RESEARCH UNIT TEACH OTHERS



STUDENTS SUCH AS JOHN HOLLIMAN, MASTERS STUDENT SHOWN ABOVE WITH RESEARCH UNIT LEADER ANN DONOGHUE, ARE AN IMPORTANT KEY TO ACCOMPLISHING THE RESEARCH CONDUCTED BY PERSONNEL IN THE PPRSU.

Dr. Philip Moore gave a lecture on the effects of pasture renovation and put on a demonstration of this technology for the Essential Elements in Watershed Planning Workshop which was put on by the Watershed Conservation Resource Center.

Dr. William Huff served as President for the Southern Poultry Science Society.

Dr. William Huff was appointed as the Section Editor for the Immunology, Health, and Disease Section of the journal Poultry Science.

Dr. William Huff served as an RPES committee chairman, and on the ARS RPES advisory board.

Student Awards with ARS Collaboration

Lakshmi Kannan, Ph.D. student, 2007 Poultry Science Association Student Research Paper Certificate of Excellence Recipient for paper Identification of antimicrobial

peptides in avian heterophils using whole cell MALDI-TOF.

Ixchel Reyes Herrera, Ph.D. student was awarded the 2007 Nicholas Student Paper Award for Turkey Research (single award for outstanding oral paper at the meeting from student Certificate of Excellence award winners for research conducted using turkeys) for paper *Campylobacter* colonization reduced and gastrointestinal architecture is altered in turkey poults fed bacteriocins.

Ixchel Reyes Herrera, Ph.D. student, 2007 Poultry Science Association Student Research Paper Certificate of Excellence Recipient for paper *Campylobacter* colonization reduced and gastrointestinal architecture is altered in turkey poults fed bacteriocins.

Vivian Aguiar, Masters student, 2007 Poultry Science Association Student Research Paper Certificate of Excellence Recipient for paper Novel isolation procedures for developing probiotic cultures against *Campylobacter* for poultry.

Fausto de los Santos, Ph.D. candidate, 2007 Poultry Science Association Student Research Paper Certificate of Excellence Recipient for paper *Campylobacter jejuni* colonization alters mucin dynamics and gut architecture in broilers.

COOPERATIVE AGREEMENTS AND TRUSTS

Newly Funded:

Red River Nutrient Criteria Development Phase I. Investigators: Brian Haggard, University of Arkansas, ARS Annie Donoghue. \$72,000

Red River Scope of Work: Nutrient Criteria Phase II. USEPA/Interagency Agreement
Investigators: Brian Haggard, University of Arkansas, ARS Annie Donoghue, \$80,000

Molecular Application Towards Understanding Bacterial Functionality In The Gastrointestinal Tract Of Poultry. Investigators: Steve Ricke, University of Arkansas, ARS Annie Donoghue

Continuing:

Evaluation and Management of Ammonia Emissions from Poultry Litter. Investigators: Philip Moore, Dana Miles, Thomas Tabler, Susan Watkins, Philip Owens, \$49,500

Measuring Edge of Field Phosphorus Losses from Pastures Fertilized with Swine Manure. Investigator: Philip Moore, Thomas Daniel; Cooperator: University of Arkansas, \$16,500

Measuring Edge of Field Phosphorus (P) Losses from Pastures Fertilized with Poultry and Swine Manure to Revise a Validate Arkansas P Index. Investigator: Philip Moore, Charlie Maxwell, Barbara Bellows, David Brauer, Paul Delaune, Dennis Carman. \$197,500

Revising the Arkansas Phosphorus Index. Investigator: Philip Moore. \$150,000

Identifying Biomarkers Associated With Poultry Leg/Skeletal Problems. Investigators: Narayan Rath, Jack Lay, Rohana Liyanage. \$57,778.00

Developing Bacteriophage Technology To Combat Disease In Poultry, CRADA partners BioDetection Instruments and the Arkansas State Diagnostic Laboratory.

Pending:

Prevention Of Colibacillosis In Poultry Using Multiple Host Range Bacteriophages, William Huff, Bio-Detection LLC. \$50,000

Conference Proposal - Avian Influenza: Vectors, Vaccines, Public Health, And Product Marketability, Geraldine Huff, CSREES \$10,000

Utilizing Water Treatment Residuals To Reduce Phosphorus Runoff From Biosolids, EPA ANRC \$110,381

Mitigation Strategies For Reducing Ammonia Emissions From Poultry, Philip A. Moore, USDA NRI \$400,000

WORKSHOPS/PEER-REVIEWED JOURNAL ARTICLES AND BOOK CHAPTERS PUBLISHED

Workshops:

Dr. Geraldine Huff made a presentation to the ARS-FSIS Food Safety Research Planning Meeting. "The effects of stress on colonization of turkeys with *Listeria monocytogenes* Scott A". Shepherdstown, WV.

Dr. Moore presented information on short-term and long-term effects of alum at a workshop put on by General Chemical.

Dr. William Huff presented a talk on mycotoxins at the International Poultry Workshop held at the University of Arkansas.

Peer-reviewed Journal Articles and Book Chapters Published:

Bielke, L.R., Higgins, S., Donoghue, A.M., Donoghue, D.J., Hargis, B.M., Tellez, G.I. 2007. Use of wide-host-range bacteriophages to reduce *Salmonella* on poultry products. *Int. J. Poultry Science* v. 6(10):754-757.

Bielke, L.R., Higgins, S., Donoghue, A.M., Kral, T., Donoghue, D.J., Hargis, B.M., Tellez, G. 2007. Evaluation of alternative host bacteria as vehicles for oral administration of bacteriophages. *Int. J. Poultry Science* v. 6(10):758-761.

Bielke, L.R., Higgins, S.E., Donoghue, A.M., Tellez, G.I., Donoghue, D.J. and Hargis, B. M. 2007. *Salmonella* host range of bacteriophages which infect multiple genera. *Poultry Science*. 86:2536-2540.

de los Santos, F.S., Donoghue, A.M., Farnell, M.B., Huff, G.R., Huff, W.E. and Donoghue, D.J. 2007. Gastrointestinal maturation is accelerated in turkey poults supplemented with a mannan-oligosaccharide yeast extract (Alphamune™). *Poultry Science*, 86:921-930.

Huff, G.R., Huff, W.E., Rath, N.C., de los Santos, F.S., Farnell, M.B, Donoghue, A.M. 2007. Influence of hen age on the response of turkey poults to cold stress, *Escherichia Coli* challenge, and treatment with a yeast extract antibiotic alternative. *Poultry Science*, 86:636-642.

Jarquín, R.L., Nava, G.M., Wolfenden, A.D., Donoghue, A.M., Hanning, I., Higgins, S.E., and Hargis, B.M. 2007. The evaluation of organic acids and probiotic cultures to reduce *Salmonella enteritidis* horizontal transmission and crop infection in broiler chickens. *Int. J. Poultry Science* 6:182-186.

Kannan, L., Rath, N.C., Liyange, R., Lay, Jr, J. 2007. Identification and Characterization of Thymosin B4 in Chicken Macrophages Using Whole Cell MALDI-TOF. *Annals of the New York Academy of Sciences*. 1112:425-434.

Pavlidis, H.O., J. Balog, L.K. Stamps, J.K. Hughes, W.E. Huff, N.B. Anthony. 2007. Divergent Selection for Ascites Incidence in Chickens. *Poultry Science*. 86:2517-2529.

Toor, G.S., Haggard, B. and Donoghue, A.M. 2007. Water extractable trace elements in poultry litters and granulated products. *J. Appl. Poult. Res.* 16:351-360.

Toor, G.S., Haggard, B.E., Reiter, M.S., Daniel, T.C., Donoghue, A.M. 2007. Phosphorus solubility in poultry litters and granulates: Influence of litter treatments and extraction ratios. *Transactions of the ASABE.* 50(2):533-542.

Torres-Rodriguez, A., Donoghue, A.M., Donoghue, D.J., Barton, J.T., Tellez, G. and B. M. Hargis. 2007. Performance and Condemnation Rates Analysis of Commercial Turkey Flocks Treated with a *Lactobacillus* spp-Based Probiotic. *Poult. Sci.* 86:444-446.

Vicente, J., Higgins, S., Bielke, L., Tellez, G., Donoghue, D.J., Donoghue, A.M., Hargis, B.M. 2007. Effect of probiotic culture candidate on *Salmonella* prevalence in commercial turkey houses. *J. Applied Poultry Res.* 16:471-476.

Wolfenden, A.D., Vicente, J.L., Bielke, L.R., Pixley, C.M., Higgins, S.E., Donoghue, D.J., Donoghue, A.M., Hargis, B.M. and Tellez, G. 2007. Effect of a defined competitive exclusion culture for prophylaxis and reduction of horizontal transmission of *Salmonella enteritidis* in broiler chickens. *Int. J. Poultry Science* 6: 489-492.

Peer-reviewed Journal Articles and Book Chapters In Press:

Blanco, J.M., Long, J.A, Gee, G., Donoghue, A.M., and Wildt, D.E. 2007. Osmotic Tolerance of Avian Spermatozoa: Influence of time, temperature, cryoprotectant and membrane ion pump function on sperm viability. *Cryobiology.*

Huff, G.R., de los Santos, F.S., Donoghue, A.M., Huff, W.E., Farnell, M.B., Rath, N.C., and Donoghue, D.J. 2007. Alphamune™ enhances turkey gut development and improves production values in both cold stress and transport stress models of *Escherichia coli* respiratory infection.

Rath, N.C., Huff, W.E., Huff, G.R. Huff. 2007. Thiram-Induced changes in the expression of genes relating to vascularization and Tibial Dyschondroplasia. *Poultry Science.*

Rath, N.C., H. Xie, W.E. Huff, G.R. Huff. 2007. Avian acute phase protein ovotransferrin modulates phagocyte function. *Immunology Research Developments.* Book Chapter.

Solis de los Santos, F., A.D. Donoghue, K. Venkitanarayanan, M.L. Dirain, I. Reyes-Herrera, P.J. Blore, D.J. Donoghue. 2007. Caprylic Acid supplemented in feed reduces enteric *Campylobacter jejuni* colonization in 10 day old broiler chickens. *Poultry Science.*

Solis de los Santos, F., Donoghue, A. M., Venkitanarayanan, K, Metcalf, J. Dirain M. L., Aguiar, V.F., Reyes-Herrera, I., Blore, P.J. and Donoghue, D. J. 2007. Therapeutic supplementation of caprylic acid in feed reduces *Campylobacter jejuni* in broiler chicks. *Appl. Envir. Micro.* Submitted.

Tomlinson, P.J., M.C. Savin, P.A. Moore. 2007. Phosphatase activities in soil after repeated untreated and alum-treated poultry litter applications. *Biology and Fertility of Soils.*

PUBLICATION LIST CONTINUED

Torres-Rodriguez, A., Higgins, S.E., Vincente, J.L.S., Wolfenden, A.D., Gaona, G., Barton, J.T., Donoghue, A.M., Tellez, G and Hargis, B.M. 2007. Effect of lactose as a prebiotic on turkey body weight under commercial conditions. *J. Applied Poultry Res.* In press.

Proceedings, Reports and Abstracts:

Aguiar, V.F. Reyes-Herrera, I., de los Santos, F.S., Dirain, M.L., Metcalf, J., Blore, P.J., Donoghue, A.M. and Donoghue, D.J. 2007. Novel isolation procedures for developing probiotic cultures against *Campylobacter* for poultry. *Poultry Sci.* 86:168.

de los Santos, F.S., Donoghue, A.M., Farnell, M.B., Huff, G.R., Huff, W.E. and Donoghue, D.J. 2007. Mannan-oligosaccharide yeast extract supplementation enhances early gut development in turkey poults. *Proceedings of the XVIth European Symposium on Poultry Nutrition*, p. 240.

de los Santos, F.S., Donoghue, A.M., Farnell, M.B., Huff, G.R., Huff, W.E. and Donoghue, D.J. 2007. Mannan-oligosaccharide yeast extract supplementation enhances early gut development in turkey poults. *XVIth European Symposium on Poultry Nutrition*, Pgs. 399-402. (Proceedings paper)

Dutta, V., G.R. Huff, W.E. Huff, N.C. Rath, M.G. Johnson, R. Nannapaneni. The effects of stress and concurrent *Escherichia coli* infection on the isolation of *Listeria monocytogenes* from synovial tissue of turkey poults. *Southern Conference on Avian Diseases*. In press

Farnell, M.B., Donoghue, A.M., de los Santos, F.S., Blore, P.J., Hargis, B.M., Tellez G. and Donoghue, D. J. 2007. Immunopotential of Avian Heterophils with Microbial Agonists. *Poultry Sci.*, 86:771.

Huff, G.R., Huff, W.E., Johnson, M.G., Nannapaneni, R. 2007. Molecular identification, characterization and assessment of virulence of non-culturable biofilm isolates of *L. monocytogenes* isolated from chronic infections of turkeys: Implications for product and plant contamination [CDROM]. *Food Safety Consortium 2006-07 Progress Reports*. Fayetteville, AR: Food Safety Consortium.

Huff, G.R., Farnell, M.B., Huff, W.E., Rath, N.R., de los Santos, F.S., and Donoghue, A.M. 2007. Effects of a dietary yeast extract, Alphamune™ on hematological parameters, heterophil function, and bacterial clearance in turkey poults challenged with *Escherichia coli* and subjected to transport stress. *Proceedings of the XVIth European Symposium on Poultry Nutrition*, p. 200.

Huff, G.R., Farnell, M.B., Huff, W.E., Rath, N.R., de los Santos, F.S., and Donoghue, A.M. 2007. Effects of a dietary yeast extract, Alphamune™ on hematological parameters, heterophil function, and bacterial clearance in turkey poults challenged with *Escherichia coli* and subjected to transport stress. *Proceedings of the XVIth European Symposium on Poultry Nutrition*, Pgs. 323-326. (Proceedings paper).

Huff, G.R. 2007. Stress, Wet Litter, and Colibacillosis. In: *Proceedings of the 1st Turkey Science and Production Conference*, April 18-20, 2007, Macclesfield, UK. p. 19-23.

Huff, G.R., Huff, W.E., Rath, N.C., Donoghue, A.M., Anthony, N.B., Nestor, K.E. 2007. Effects of sex and genetics on behavior and stress response of turkeys [abstract]. 2nd World Conference of Stress, Aug 23-26, 2007, Budapest, Hungary. p. 289.

Huff, G.R., de los Santos, F.S., Huff, W.E., Rath, N.C., Donoghue, A.M. and Donoghue, D.J. 2007. Yeast improves resistance to environmental challenges. *World Poultry* 23:12-14.

Metcalf, J. , Venkitanarayanan, K., de los Santos, F.S., Donoghue, A.M., Dirain, M., Reyes-Herrera, I., Aguiar, V., Blore, P.J. and Donoghue, D.J. (2007) Dosing with the fatty acid, sodium caprylate in the water did not reduce enteric *Campylobacter* concentrations in broilers. *Poultry Sci.* 86:224-225.

Moore, P.A., D.M. Miles, R. Burns, D.H. Pote, K. Berg. 2007. Management Options for Reducing Ammonia Emissions from Poultry Litter. In Proceedings for the International Ammonia in Agriculture Conference, Wageningen, The Netherlands, March 17-25, 2007.

Reyes-Herrera, I. Cole, K., de los Santos, F.S., Donoghue, A.M., Stern, N.J. Svetoch, E.A., Eruslanov, B.N., Perelygin, V.V., Mitsevich, E.V., Mitsevich, I.P., Levchuk, V. P.M. Farnell, M.B., Blore, P.J. and Donoghue, D.J. (2007) *Campylobacter* colonization reduced and gastrointestinal architecture is altered in turkey poults fed bacteriocins. *Poultry Sci.*, 86:382.

Solis de los Santos, F., Dirain, M.L., Blore, P.J., Reyes-Herrera, I. Donoghue, A.M. and D. J. Donoghue (2007) *Campylobacter jejuni* colonization alters mucin dynamics and gut architecture in broilers. *Poultry Sci.* 86:250.

Solis de los Santos, F., Donoghue, A.M, Venkitanarayanan, K., Dirain, M.L., Metcalf, J., Reyes-Herrera, I., Aguiar, V.F., Blore, P.J. and D. J. Donoghue (2007) Caprylic acid as a dietary supplement has therapeutic efficacy against enteric *Campylobacter jejuni* in chickens. Proceedings of the 14th International Workshop on *Campylobacter*, *Helicobacter* and Related organisms. Rotterdam, p. 13.

Toor, G.S., Haggard, B., Williamson, S.M. and Donoghue, A.M. 2007. Granulating poultry litter and environmental consequences- final project report. U.S. Poultry and Egg Association. pp.37.

PATENTS SUBMITTED/ GRADUATE STUDENTS

Patents: 3 submitted

Graduate Students:

Master's or doctoral students not yet finished

Graduate Students Advised as Major Professor or Committee Member (At UA)

ARS Member	Graduate Student	Degree/Department	Member/Advisor	Year/s	
Donoghue, Ann	de los Santos, Fausto Solis	Ph.D./POSC	Member	2004-2008	
	Metcalf, Joel	M.S./POSC	Member	2006-2008	
	Aguiar, Vivian	M.S./POSC	Member	2006-2008	
Huff, Geraldine	Lakshmi, Kannan	Ph.D./CEMB	Member		
	Dutta, Vikrant	M.S./POSC	Advisor	2005-2007	
Huff, William	Spanakos, Manolis	Ph.D./POSC	Member	2005-2007	
	Durairaj, Vijay	M.S./POSC	Member	2007-2008	
	Coto, Cesar	M.S./POSC	Member	2006-2007	
	Sandro Cerrate	M.S./POSC	Member	2006-2008	
	Zurong Wang	M.S./POSC	Member	2006-2008	
	Rath, Narayan	Durairaj, Vijay	M.S./POSC	Advisor	2007
	Rasaputra, Komal	Ph.D./POSC	Advisor	2007	
Kannan, Lakshmi	Kannan, Lakshmi	Ph.D./CEMB	Advisor	2007	
	Hamal, Krishna	Ph.D./POSC	Member	2007	
	Lorenzoni-Calvo, Gino	Ph.D./POSC	Member	2007	
	Kannan, Arvind	Ph.D./CEMB	Member	2007	
	Koteshwara, Ananthamurthy	Ph.D./Chemistry and Biochemistry	Member	2007	
Devarapalli, Nagarjuna	Devarapalli, Nagarjuna	Ph.D./Chemistry and Biochemistry	Member	2007	
	Moore, Philip			No students	

Master's or doctoral students who completed their degree requirements during calendar year

ARS Member	Graduate Student	Degree/Department	Member/Advisor	Year/s
Huff, Geraldine	Dutta, Vikrant	M.S./POSC	Advisor	Dec 2007
	Spanakos, Manolis	Ph.D./POSC	Member	Dec 2007
Rath, Narayan	Manangi, Meghraj	Ph.D./POSC	Member	Dec 2007
Donoghue, Ann	de los Santos, Fausto Solis	Ph.D./POSC	Member	Dec 2007