

**Southeast
Dairy
Foods
Research
Center**

**Annual
Report
2010**



SDFRC



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Annual Report 2010

SDFERC



**Southeast Dairy Foods Research Center
North Carolina State University
Department of Food Bioprocessing & Nutrition Sciences
Campus Box 7624
Raleigh, NC 27695-7624**

Introduction

This report summarizes the activities of the Southeast Dairy Foods Research Center (SDFRC) for the 2010 calendar year. The center has been in operation since 1988, and in 2010 recognized twenty-two years under the direction of the Dairy Management, Inc. (DMI) currently administered by the Dairy Research Institute (DRI, Rosemont, IL). The SDFRC continues to actively participate in national research planning and coordinates its activities with our industry members, academic researchers, and the directors of the other five national centers.

The SDFRC houses a broad collection of expertise in dairy science and technology. Investigators are working in research areas of high national priority as consistently defined in industry surveys. Areas of research emphasized in this center are notably in whey protein functionality, extended shelf-life processing, probiotics, dairy starter cultures, and the flavor, chemistry and sensory quality of cheese and dairy ingredients.

In 2010 the center was awarded \$486,607 in funds from DRI for 16 active grants, plus an additional \$389,261 in funds from aligned industrial sources and dairy promotion groups to achieve a funding total of \$875,868. Investigators working in the SDFRC published seventeen refereed journal publications, fourteen abstracts, and gave twenty-five scientific and technical presentations. Two M.S. theses were completed. The center sponsored several dairy-related workshops and was very active in promoting the outcomes of funded research at local, national, and international meetings.

In 2010, there were twenty-eight members of SDFRC's Operational Advisory Committee representing fourteen innovative regional and national companies processing dairy products, functional dairy ingredients, probiotics, and foods formulated with dairy components. The National Dairy Foods Research Centers are closely aligned with industrial partners to help define the key research issues and facilitate the transfer of new information and technology into the production of dairy products and ingredients. We are very proud to be associated with our industrial partners and grateful for their multidimensional input into our center programs with their expertise, experience, time commitment, funding, and their vision for the future.

Nationally, the SDFRC and aligned center programs are integrated with DRI, industry and local/regional promotion and processor organizations. The SDFRC program is positively positioned within a cooperative national organization and committed to generating knowledge, innovation, and young scientists through research, to support the growth and competitiveness of the dairy industry into the future.

Contents

Introduction.....	1
Operational Advisory Committee Members.....	7
Contributing Industrial Members.....	8
Faculty, Staff and Students	9
Additional Dairy Research by SDFRC Investigators	10

Technology Transfer

Refereed Journal Articles.....	13
Seminars, Presentations, Workshops and Short Courses.....	15
Published Abstracts.....	17
Graduate Theses Completed	18

Research Project Reports

Dairy Component Functionality

Identification of chemical components responsible for specific flavors in WPC80 and WPI M.A. Drake	23
Improving whey protein off-flavor prevention via alternative process step optimization M.A. Drake, P.S. Tong	26
Enhancing the quality and utilization of native whey proteins M.A. Drake, E.A. Foegeding	33
Quantification & aroma quality of the compounds needed for cheese flavor in low fat cheddar cheese. M.A. Drake	39
Modifying whey protein to improve heat stability and clarity at neutral pH E.A. Foegeding	43
Developing whey proteins having less astringency at low pH E.A. Foegeding	55
Binding calcium to improve stability of whey protein E.A. Foegeding	63

Designing filler particles to imitate fat in Cheddar cheese E.A. Foegeding	69
---	----

General Dairy Science and Technology

Understanding the role of beverage processing steps on whey protein flavor contributions M.A. Drake	77
--	----

Sensory Applications Lab 2010 M.A. Drake	86
---	----

At what salt level do consumers notice decreasing salt concentrations and at what concentration is acceptance negatively impacted M.A. Drake	90
---	----

Investigating the filled gel model for the role of fat in cheese E.A. Foegeding	98
--	----

Enhancing microbial safety of fresh soft Queso fresco cheese by GRAS lauric arginate application R. Nannapaneni, Mississippi State University.....	105
---	-----

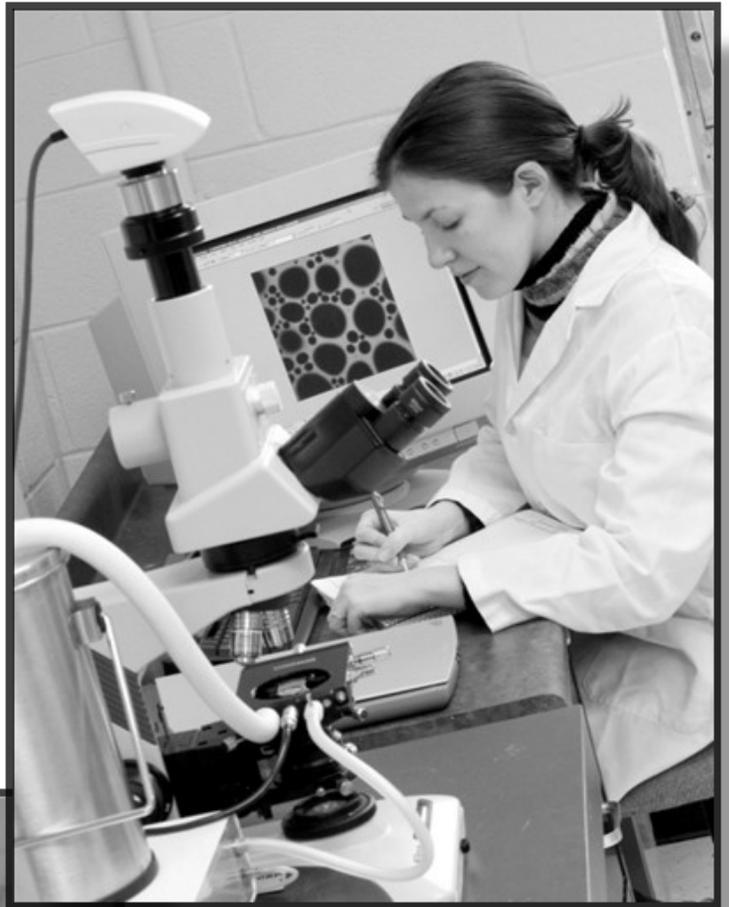
Starter Cultures and Probiotics

Influence of starter culture growth on the development of rosy and burnt-brothy flavors during aging of low fat cheese M.A. Drake	111
--	-----

Identification of probiotic features in <i>Lactobacillus acidophilus</i> affected by dairy delivery T.R. Klaenhammer.....	115
--	-----

Influence of lactic acid bacteria, milk, yogurt, and milk components on gene expression in human intestinal epithelial cells T.R. Klaenhammer.....	127
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Overview And Progress Update



Purpose of Report

This report summarizes the activities of the Southeast Dairy Foods Research Center for the period January 1, 2010 through December 31, 2010.

In 2010 there were 16 active projects supported by Dairy Research Institute. Additional dairy-related projects funded from non-DRI matching sources, federal grants, the NC Dairy Foundation, and industry members are listed on page 10.

Operational Advisory Committee

The Operational Advisory Committee (OAC) advises the center on overall policies and program goals and develops short and long-term research objectives to ensure that approved projects meet the research directives of the SDFRC and the National Research Plan.

Operational Advisory Committee Members

Eric Bastian, Vice President, Research & Development, Glanbia R&D Center
Arti Bedi, Director of Research & Development, Land O'Lakes, Inc.
Robert Burrage, Representative, North Carolina Dairy Foundation
Gary Cartwright, Director of the Dairy Enterprise System, Department of Food, Bioprocessing and Nutrition Sciences, NCSU
Connie Cerdena, Manager R&D New Platforms Group, Pepsico, Inc.
Chris Daubert, Interim Head, Department of Food, Bioprocessing and Nutrition Sciences, NCSU
Laurie Davis, Co-Director, Davisco International, Inc.
Mitch Davis, Co-Director, Davisco International, Inc.
E. Allen Foegeding, W.N. Reynolds Distinguished Professor, Department. of Food, Bioprocessing and Nutrition Sciences, NCSU
Bill Graves, Senior Vice President, Product Research, Dairy Research Institute
Tom Helm, Director of Food Technology, Grande Cheese Company
Alice Heth, Director Yoplait New Ventures in Research & Development, General Mills
Todd Klaenhammer, SDFRC Director, Distinguished Univ. Professor, Department of Food, Bioprocessing and Nutrition Sciences, NCSU
Veronique Lagrange, Vice President of Strategic Research and Business Development, US Dairy Export Council
Isabelle Laye, Principal Scientist Cheese & Dairy, Kraft Foods, Inc.
Joseph Light, Senior Director, National Starch & Chemical Co.
Dave McCoy, Vice President Product Research, Dairy Research Institute
Fu I. Mei, Program Manager, Kraft Global Technology
William Benjy Mikel, Head, Dept. of Food Science, Nutrition & Health Promotion, MSU
Barbara Miller, Microbiome Platform Manager, Proctor & Gamble Global Microbiology
Kees Muijlwilk, Product & Application Developer Dairy Enzymes, DSM Food Specialties
Brandon Nelson, Manager of R & D, Daisy Brand
Mike Nygaard, Director of Technical Services Ingredients, Darigold, Inc.

Keith Oakley, Executive Director for College Advancement, NCSU
Kayla Polzin, Group Leader for Microbiology, Cargill, Inc
Dennis Romero, Technical Director, Danisco USA, Inc.
KP Sandeep, CAPPS Director, Professor, Department of Food, Bioprocessing and
Nutrition Sciences, NCSU
Eric Young, Exec Director, Southern Association of Agricultural Experiment Station
Director

Industrial Memberships

- Cargill, Inc.
- Darigold, Inc.
- Daisy Brand
- Danisco USA, Inc.
- Davigo Foods International, Inc.
- DSM Food Specialties
- General Mills/Yoplait
- Glanbia Nutritionals
- Grande Cheese Company
- Kraft Foods Global
- Land O' Lakes, Inc.
- National Starch & Chemical Company
- PepsiCo, Inc.
- Proctor & Gamble
- U.S. Dairy Export Council

Associate Members

- North Carolina Dairy Foundation
- Southeast United Dairy Industry Association

Faculty, Staff and Students

The following faculty, staff and students contributed to research and program activities conducted within the Southeast Dairy Foods Research Center during the reporting period.

Jonathan C. Allen, NCSU
Joakim Andersen, NCSU
Aaron Anders, NCSU
Leann M. Barden, NCSU
Tristan Berry, NCSU
Molly Burke, NCSU
Rachel Campbell, NCSU
Gary Cartwright, NCSU
Jessica Childs, NCSU
Debra Clare, NCSU
Adam Croissant, NCSU
Luciana Cunha, NCSU
Christopher Daubert, NCSU
Grace Douglas, NCSU
MaryAnne Drake, NCSU
Stephenie Drake, NCSU
Evelyn Durmaz, NCSU
Joshua Evans, NCSU
E. Allen Foegeding, NCSU
Aaron Fox, NCSU
Kathryn Fox, NCSU
Y. Jun Goh, NCSU
Carl Hollifield, NCSU
Sue Jervis, NCSU
Yu Jiang, NCSU
Jamie Kang, NCSU
Mina Kim, NCSU
Todd R. Klaenhammer, NCSU
Iris Liaw, NCSU
Pat Leksrisonpong, NCSU

Maria Listyani, NCSU
Mallorye Lovett, NCSU
Shirley Lyles, NCSU
Paige Luck, NCSU
Donald McMahon, Utah State University
Evan Miracle, NCSU
Ramakrishna Nannapaneni, Mississippi State Univ.
Sarah O'Flaherty, NCSU
Quin Patton, NCSU
Chris Pernell, NCSU
Sharon Ramsey, NCSU
Carol Reilly, NCSU
Neil Rogers, NCSU
Kelsey Ryan, NCSU
Rosemary Sanozky-Dawes, NCSU
Kurt Selle, NCSU
Joel Schroeter, NCSU
Margaret Schneider, NCSU
Wes Schilling, Mississippi State University
Kamlesh Soni, Mississippi State University
Chuan-He Tong, NCSU
Bongkosh Vardhanabhuti, NCSU
Ruth Watkins, NCSU
Drew Watson, NCSU
Samantha White, NCSU
Megan Whitson, NCSU
Xin Yang, NCSU
Michele Yates, NCSU

Additional Dairy Research Grants/Projects Funded for SDFRC Investigators

Drake, M.A. Flavor and color of whey protein concentrates bleached with hydrogen peroxide or alternative enzymatic bleach. DSM Food Specialties.

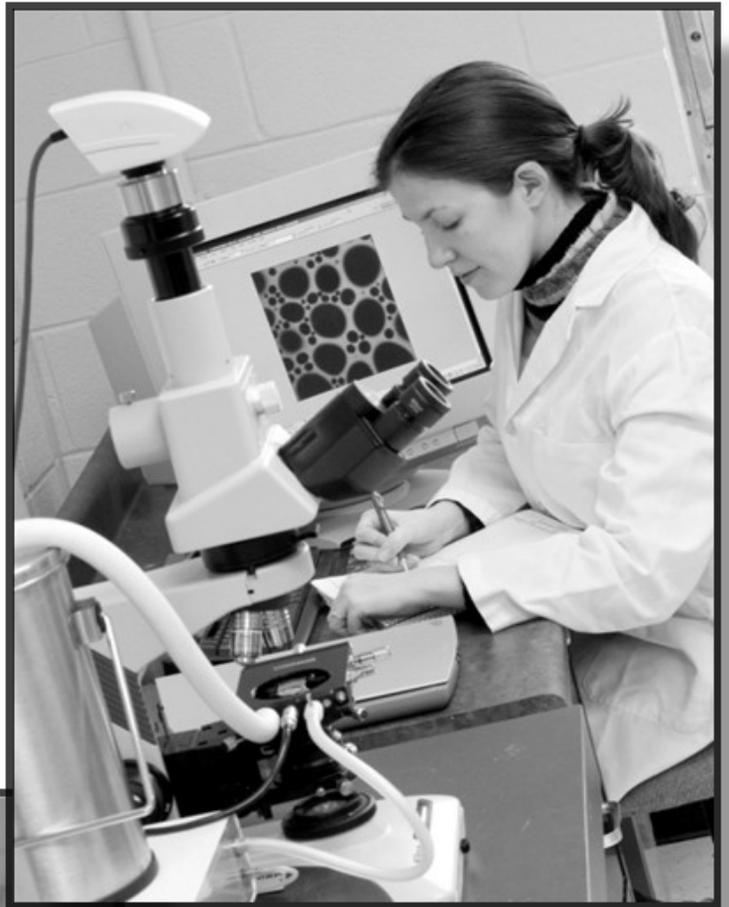
Drake, M.A. The role of bleaching on whey and serum protein concentrates. New York State Dairy Commission. (joint project with D.M. Barbano at Cornell Univ)

Foegeding, E.A., USDA-NRICGP research grant: *Mechanisms responsible for astringency of whey proteins at low pH*, August 1, 2006 – July 31, 2010

Klaenhammer, T. R. Functional genomics on *Lactobacillus acidophilus* NCFM. Danisco USA, Inc., For 2010.

Klaenhammer, T.R. Characterization of lactic acid bacteria. Procter & Gamble. 2010.

Technology Transfer



Publications

Refereed Journal Articles

Childs, J.L. and Drake, M.A. 2010. Consumer perception of astringency in acidic whey protein beverages. *J. Food Sci.* 75:S513-S521.

Douglas, G. and Todd R. Klaenhammer. 2010. Genomic evolution of domesticated microorganisms. *Ann. Rev. Food Sci. & Technol.* 1: 397-414.

Drake, M.A., Miracle, R.E., and McMahon, D.J. 2010. Impact of fat reduction on flavor and flavor chemistry of cheddar cheeses. *J. Dairy Sci.* 93:5069-5081.

Drake, M.A., Miracle, R.E., and McMahon, D.J. 2010. Influence of fat on flavour and flavour development of Cheddar cheese. *Australian J. Dairy Technol.* 65(3):644-650.

Drake, S.L., Yates, M.D., and Drake, M.A. 2010. Development of a sensory lexicon for processed and imitation cheeses. *J. Sensory Stud.* 25:720-739.

Goh, Y. J. and T. R. Klaenhammer. 2010. Functional roles of aggregation-promoting-like factor in stress tolerance and adherence of *Lactobacillus acidophilus* NCFM. *Appl. Environ. Microbiol.* 76:5005-5012.

Kang, E.J., Campbell, R.E., Bastian, E., and Drake, M.A. 2010. Annatto and bleaching in dairy foods. Invited review. *J. Dairy Sci.* 93:3891-3901.

Kim, M.K., Drake, S.L., and Drake, M.A. 2010. Evaluation of key flavor compounds in reduced and full fat Cheddar cheese using sensory studies on model systems. *J. Sensory Stud.* *Submitted.*

Leksrisonpong, P., Barbano, D.M., Foegeding, E.A., Gerard, P.D., and Drake, M.A. 2010. The roles of fat and pH on detection thresholds and partition coefficients of volatile compounds. *J. Sensory Studies.* 25: 347-370.

Liaw, I., Eshpari, H., Tong, P.S., and Drake, M.A. 2010. The impact of antioxidant addition on flavor of Cheddar and Mozzarella whey and Cheddar whey protein concentrate. *J. Food Sci.* 75:C559-C569.

O'Flaherty, S., D. Saulnier, B. Pot and J. Versalovic. (2010). How can probiotics and prebiotics impact mucosal immunity? *Gut Microbes.* 1:5, 1-8

O'Flaherty, S. and T.R. Klaenhammer (2010). The role and potential of probiotic bacteria in the gut, and the communication between gut microflora and gut/host. *International Dairy Journal*, (20) 4: 262-268

O'Flaherty, S., and T.R. Klaenhammer (2010). Functional characterization of a protein from *Lactobacillus acidophilus* involved in cell morphology, stress tolerance and adherence to intestinal cells. *microbiology*. 156: 3360 – 3367

Nannapaneni, Soni, K., R., M. W. Schilling, and V. Jackson. 2010. Bactericidal activity of GRAS lauric arginate against *Listeria monocytogenes* in milk and Queso fresco cheese. *Journal of Dairy Science* 93: 4518-4525.

Palacios, O.P., Badran, J., Spence, L., Drake, M.A., Reisner, M. and Moskowitz. H.R. 2010. Measuring acceptance of milk and milk substitutes among younger and older children. *J. Food Sci.* 75:S522-S526.

Rogers, N.R., McMahon, D.J., Daubert, C.R., Berry, T.K. and Foegeding, E.A. 2010. Rheological properties and microstructure of Cheddar cheese made with different fat contents. *Journal of Dairy Science* 93:4565-4576.

Whitson, M.E., Miracle, R.E., Drake, M.A. 2010. Sensory characterization of chemical components responsible for cardboard flavor in whey protein. *J. Sensory Stud.* 25:616-636.

Book Chapters

Azcarate-Peril, M.A. and T.R. Klaenhammer. 2010. The Genomics of Lactic Acid Bacteria: The post genomics challenge – from sequence to function. In, *Biotechnology of Lactic Acid Bacteria*, Mozzi, F., Raya, R.R., and dVignolo, G.M (Eds). Wiley-Blackwell, pp. 35-56.

Drake, S.L. and Drake, M.A. 2011. Application of Sensory Methods to Development of Probiotic and Prebiotic Foods. Ch 6 In *Probiotic and Prebiotic Foods. Technology, Stability and Benefits to Human Health*. Nov Science Publishers, New York, NY pp 113-130.

Seminars, Presentations, Workshops and Short Courses

Andersen, J. M., R. Barrangou, M. A. Hachem, B. Svensson, Y. J. Goh, and T. R. Klaenhammer. 2010. Transcriptional analysis of prebiotic utilization by *Lactobacillus acidophilus* NCFM. Presented at the American Society for Microbiology 110th General Meeting in San Diego, CA.

Barden, L.M., McMahon, D.J., and Foegeding, E.A. Investigating the filled gel model for the role of fat in cheese. Poster presentation, July 18, 2010. Institute of Food Technologists Annual Meeting, Chicago, IL.

Douglas, G.L., and T.R. Klaenhammer. 2010. Directed chromosomal integration and expression of the reporter gene, *gusA3*, in *Lactobacillus acidophilus* NCFM. 2nd ASM conference on Beneficial Microbes, Miami.

Drake, M.A. 2010. Dairy Flavors. Hands-on Tasting and workshop presentation. Agrimark, Burlington, VT Feb 7-9.

Drake, M.A. 2010. Defining Flavor of Aged Cheddar Cheeses, hands-on workshop. American Cheese Society, Aug 25-28. Seattle, WA.

Drake, M.A. 2010. Defining Flavor of Aged Cheddar Cheeses, hands-on workshop. Cabot Coop, Oct. 4, Cabot, VT.

Drake, M.A. 2010. Flavor and flavor chemistry of dried dairy ingredients and ingredient applications. Clorox, May 3. Pleasanton, CA.

Drake, M.A. 2010. Flavor and flavor chemistry of dried dairy ingredients. Land O Lakes, Inc. Minneapolis, MN June 30

Drake, M.A. 2010. Flavor and flavor chemistry of low fat Cheddar cheeses. International Dairy Federation Conference, Nov 7-13. Auckland, NZ.

Drake, M.A. 2010. Flavor development in low fat cheese. Southeast Dairy Foods Research Center, North Carolina State University, Raleigh. ASAS/ADSA Annual Meeting, Denver, CO, July 12-16. Abstract 297 (Symposium)

Drake, M.A. 2010. Integration of sensory and instrumental analyses. Daisy Brand, Dallas, TX Dec 28-29.

Drake, M.A. 2010. Milk powder flavor and flavor variability, hands on workshop. General Mills, Minneapolis, MN. Aug 13

Drake, M.A. 2010. Perceived product value and the language on the label. American Cheese Society, Aug 25-28, Seattle, WA.

- Drake, M.A. 2010. The impact of bleaching on the flavor of whey and whey protein. Cornell Dairy Center Conference, Jan 7-8, Ithaca, NY
- Drake, M.A. 2010. The impact of bleaching on the flavor of whey protein. Syracuse/Cornell Dairy Conference, March 1-2, Syracuse, NY.
- Drake, M.A. 2010. The impact of bleaching on the flavor of whey protein. Carbery, April 12, Cork, Ireland.
- Drake, M.A. 2010. The impact of bleaching on the flavor of whey protein. DSM Food Specialities, Delft, The Netherlands, June 16.
- Drake, M.A. 2010. The influence of processing parameters on whey protein flavor. Davisco Foods, Minneapolis MN Dec 13-14.
- Drake, M.A. 2010. The influence of processing parameters on whey protein flavor. University of Illinois, Sept. 30, Savoy, IL.
- Klaenhammer, T.R. 2010. Application of omic tools to understanding probiotic action. American Dairy Science Association, Denver.
- Klaenhammer, T.R. 2010. Functional genomics of probiotics. Institute of Food Technologists, Chicago.
- Klaenhammer, T. 2010. Genomic analysis of probiotic cultures – genes to traits. International Probiotic Association, Miami.
- Nannapaneni, Soni, K., R., W. Schilling, and V. Jackson. 2010. Bactericidal activity of GRAS lauric arginate against *Listeria monocytogenes* in milk and Queso fresco cheese, Poster approved for presentation at the International Association for Food Protection, Aug 1-4, 2010, Anaheim, CA.
- O’Flaherty and T.R. Klaenhammer (2010) Influence of *Lactobacillus acidophilus* and yogurt on gene expression in human intestinal epithelial cells in vitro. USA/Ireland Functional Foods Conference 2010.
- Ryan, K.N. and Foegeding, E.A. Aggregation mechanism of whey protein soluble aggregates at neutral pH. Institute of Food Technologists Annual Meeting, July 17-20, 2010. Chicago, IL. Presented in the Dairy Division John Bruhn Graduate Poster Presentation Competition; Kelsey took 3rd place.

2010/2011 North Carolina Dairy Technology Meetings

September	NC Dairy Technology Outing, Winston Salem
November	NC Dairy Technology Meeting, High Point
March	NC Dairy Technology Meeting, High Point
April	Senior Design Project Presentation, High Point
May	NC Dairy Technology Networking, Winston Salem

Published Abstracts

Barden, L.M., McMahon, D.J., and Foegeding, E.A. Investigating the filled gel model for the role of fat in cheese. Book of abstracts. July 18, 2010. Institute of Food Technologists Annual Meeting, Chicago, IL.

Campbell, R.E., Miracle, R.E., and Drake, M.A. 2010. The impact of starter culture and annatto on the flavor and functionality of whey protein concentrate. ASAS/ADSA Annual Meeting, Denver, CO, July 12-16. Abstract 128

Campbell, R.E., Miracle, R.E., Drake, M.A. 2010. Sensory and volatile analysis of annatto in fluid whey. IFT Annual Meeting, Chicago, IL. July 18-21. Abstract 154-04.

Childs, J.L., Lopetcharat, K., and Drake, M.A. 2010. Influence of regional labeling on consumer perception of Cheddar cheese. IFT Annual Meeting, Chicago, IL. July 18-21. Abstract 160-18.

Drake, M.A. 2010. Sensory frontiers in texture measurement. IFT Annual Meeting, Chicago, IL. July 18-21. Abstract 173-04. (symposium)

Drake, S.L. and Drake, M.A. 2010. Sensory profiles of different sea salts from around the world. IFT Annual Meeting, Chicago, IL. July 18-21. Abstract 160-13.

Fox, K., Childs, J., Jervis, S., Miracle, R.E., Drake, M.A. 2010. The impact of heating and acidification on flavor of whey protein isolate. IFT Annual Meeting, Chicago IL July 18-20. Accepted. Abstract D-54

Kang, E.Y. and Drake, M.A. 2010. Acid activated bentonite as an alternative for peroxide bleaching of whey. IFT Annual Meeting, Chicago, IL. July 18-21. Abstract 184-06.

Kang, E.J., Drake, M.A. 2010. Bleaching liquid Cheddar whey using ultraviolet radiation. ASAS/ADSA Annual Meeting, Denver, CO, July 12-16. Abstract M176

Kim, M., Drake, S.L., Senel, E., and Drake, M.A. 2010. Desirable flavor compound concentrations in low fat Cheddar cheese. IFT Annual Meeting, Chicago, IL. July 18-21. Abstract 154-05.

Listiyani, M.A.D., Campbell, R.E., Miracle, R.E., Barbano, D.M., and Drake, M.A. 2010. Impact of temperature and fat content on bleaching of liquid whey. ASAS/ADSA Annual Meeting, Denver, CO, July 12-16. Abstract M175

Nannapaneni, Soni, K., R. W. Schilling, and V. Jackson. 2010. Bactericidal activity of GRAS lauric arginate against *Listeria monocytogenes* in milk and Queso fresco cheese, Abstract approved for presentation at the International Association for Food Protection, Aug 1-4, 2010, Anaheim, CA.

O'Flaherty, S. and T.R. Klaenhammer (2010). Influence of *Lactobacillus acidophilus* and yogurt on gene expression in human intestinal epithelial cells *in vitro*. USA/Ireland Functional Foods Conference 2010.

Ryan, K.N., B. Vardhanabhuti, and E.A. Foegeding. Aggregation mechanism of whey protein soluble aggregates at neutral pH. K.N. Ryan*, B. Vardhanabhuti, and E.A. Foegeding. Institute of Food Technologists Annual Meeting, July 17-20, 2010. Chicago, IL.

Graduate Theses Completed

Barden, L.M. Textural Properties of Cheddar Cheese. North Carolina State University, M. S. thesis.

Campbell, R.E. 2010. The role of starter culture and annatto on whey protein flavor. M.S. thesis, North Carolina State Univ. Raleigh, NC.

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