Dairy Foods: Forum on Cheese Ripening

156 Combined abstract for forum on cheese ripening symposium presentations. W. J. Harper*[1], M. Johnson[2], J. Broadbent[3], J. Lucey[2], and M. Drake[4], [1]*The Ohio State University*, *Columbus*, [2]*University of Wisconsin*, *Madison,*, [3]*Utah State University*, *Logan,*, [4]*North Carolina State University*, *Raleigh*.

Organizer: Jim Harper, The Ohio State University, Columbus

This symposium is a forum to provide a broader discussion on this specific topic of interest-Cheese Ripening. The five participants will be discussion facilitators. This format will allow greater audience participation than normally occurs in the traditional symposium format.

Discussion facilitators and the various topics are:

a. Jim Harper, The Ohio State University, Columbus-Cheese Ripening -A Historical Perspective

b. Mark Johnson, University of Wisconsin, Madison-Milk and the Cheese Maker

c. Jeff Broadbent, Utah State University, Logan -Microbiology and Biochemistry

d. John Lucey, University of Wisconsin, Madison-Chemistry and Physical Properties

e. MaryAnne Drake, North Carolina State University, Raleigh-Flavor

f. Open Discussion with Audience Participation for the remainder of the time

Key Words: Cheese Ripening, Milk and Cheese Making, Changes during Ripening

Graduate Student Competition: National ADSA Dairy Foods

157 Identification of genes associated with *Mycobacterium avium* subsp. *paratuberculosis* entry into cultured bovine epithelial cells. D. Patel*, L. Meunier-Goddik, and L. E. Bermudez, *Oregon State University*, *Corvallis*.

Mycobacterium avium subsp. *paratuberculosis* (MAP) is the etiologic agent of Johne's disease (JD) in ruminants. The intestinal tract is believed to be an important route of MAP infection, but MAP genes with role in the invasion of intestinal epithelial cells are mostly unknown. The objective of this investigation was to create and screen the signature-tagged mutagenesis (STM) based MAP transposon library for invasion-associated genes. A mixed tag plasmid pYJ that contains transposon Tn *5367* and a kanamycin-resistance gene as a selectable marker was used for STM library. From 33 signature-tagged clones, a library of total 1980 mutants was constructed. Invasion assays were carried out for individual clones and efficiency of invasion was calculated as percentage of inoculated bacteria that entered MDBK cells after 2 h contact time compared with the wild type bacteria screened under the same conditions. Screening of 600 mutants identified clones 2C12, 2δ5, 2δ6 and 2D1 with impaired ability to enter MDBK epithelial cells ($p < 0.01$). The genes flanking transposon insertion site were identified by nucleotide sequence analysis using transposon primers. The gene sequence analysis based on BLAST program of National Center for Biotechnology resulted in the identification of mycobacterial cell entry (*mce1*D) operon, oxidoreductase operon, NADH-ubiquinone-oxidoreductase (*nuo*L), and a potassium transporter (*trk*A) as invasion-associated genes for MAP entry into MDBK epithelial cells. The cross genome comparison of identified genes suggests that role of *mce1*D in invasion may be due to its direct participation in epithelial cell entry. The role of *nuo*L and *trk*A in invasion may be through sensor response resulting in upregulation of invasion-associated genes. The role of oxidoreductase may be through catalytic protein folding influencing secretion of virulence factors. The identification of invasion-associated genes will be useful for characterizing bacterial factors associated with the MAP infection of bovine host.

Key Words: Invasion-Associated Genes, Johne's Disease, *Mycobacterium avium* Subsp. *paratuberculosis*

158 Flavor profiles of full fat, reduced fat and cheese fat made from aged Cheddar with the fat removed using a novel process. M. Carunchia Whetstine*[1], M. Drake[1], B. Nelson[2], and D. Barbano[2], [1]*North Carolina State University*, *Raleigh*, [2]*Cornell University*, *Ithaca, NY*.

Many consumers are concerned with fat intake. However, reduced fat cheeses may lack robust flavors. The objectives of this study were to characterize the flavors found in full fat cheese, cheese fat and reduced fat cheese made from aged Cheddar using a novel process to remove the fat (JDS 87:841). Two aged cheeses (12 months and 42 months) were selected, and the fat was removed using the novel fat removal process. Full fat cheeses, corresponding reduced fat cheeses and cheese fats were then analyzed using descriptive sensory and instrumental analysis. Cheeses were extracted with diethyl ether, followed by isolation of volatile material by high vacuum distillation. Volatile extracts were analyzed using gas chromatography-olfactometry (GCO) with aroma extract dilution analysis (AEDA). Selected compounds were quantified. The 12 month cheese was characterized by fruity and sulfur notes, while the 42 month old cheese was characterized by a spicy brothy flavor. Reduced fat cheeses had very similar flavor profiles to corresponding full fat cheeses. Sensory profiles of the cheese fats were characterized by low intensities of the prominent flavors found in the full fat cheeses. Instrumental analysis revealed similar trends. Consistent with sensory analysis, there were lower concentrations and log3FD factors for most compounds in the cheese fats compared to both the reduced and full fat cheeses, regardless of compound polarity. This study demonstrates that when fat is removed from aged Cheddar cheese, most of the flavor and flavor compounds remain in the cheese and are not removed with the fat.

Key Words: Reduced Fat Cheese, GC/O, Flavor Partitioning

159 Development and application of an image analysis method to quantify calcium lactate crystals on cheddar cheese. P. Rajbhandari* and P. Kindstedt, *University of Vermont*, *Burlington*.

Calcium lactate crystals that form white specks or haze on

the surface of cheese constitute a significant quality problem for producers of Cheddar cheese. Subjective methods to evaluate crystal coverage of cheese surfaces have been reported previously, but objective methods are currently lacking. The goals of this research were to develop and evaluate an objective method to measure the area occupied by calcium lactate crystals on surfaces of naturally smoked Cheddar cheese samples using digital photography and image analysis. Coefficients of variation ranged from 1.19 to 4.7% for 5 replicate analyses of 3 different cheese surfaces that ranged from ca. 2 to 49% of total surface area occupied by crystals. Thus, results showed a high degree of repeatability for the 3 cheese surfaces, which ranged from very slight and geometrically simple to very heavy and geometrically complex crystal coverage.The method underestimated total area occupied by crystals on the 3 surfaces by 0.3 to 4.8% unless the faint crystal regions that went undetected during initial thresholding were manually segmented and quantified. The wet weight of crystal substance collected per unit of surface area from 20 different cheese samples increased exponentially as the percentage of total surface area occupied by crystals increased. These data were consistent with subjective observations that crystal regions appeared to grow vertically as well as horizontally as they expanded to occupy greater surface area. Image analysis was well suited for evaluating