rheological (hardness, springiness, cohesiveness, chewiness, elastic and viscous modulus, torsion shear stress and shear strain) properties of soft (Panela, Queso Fresco), semi-hard (Mexican Mennonite, Oaxaca), and hard (Cotija) commercially manufactured Hispanic-style cheeses. The cheeses were obtained from Mexico (Mennonite-style) and the US. Soft cheeses typically contain over 50% moisture, 18 to 25% fat, 17 to 22% protein and 1-3% salt, have pH $\geq$ 6.0, and low meltability. The semi-hard cheeses contain 40 to 50% moisture, 18 to 25% fat, 20 to 30% protein, and 0.8 to 2% salt, pH from 5.0 to 5.5 and high meltability. Cotija, the most common hard cheese, contains less than 40% moisture, 23 to 30% fat, 23 to 30% protein, over 4% salt, pH 5.6, and has intermediate meltability. The semi-hard cheeses showed the greatest total color change upon heating which was related to their high meltability. All soft cheeses were similar in springiness and cohesiveness, but varied in hardness, chewiness, rigidity, and viscoelastic properties. All semi-hard cheeses were similar in springiness, cohesiveness, and viscoelastic properties, but varied in chewiness and rigidity. Cotija was similar to the semi-hard cheeses in springiness and viscoelastic properties. Compared to the soft cheeses, the semi-hard and hard cheeses had higher values of springiness, cohesiveness, chewiness, and viscoelastic properties. These results are discussed in terms of the processing steps that are used to manufacture these cheeses.

Key Words: Hispanic cheese, Functionality, Rheology

Dairy Foods Symposium: Listeria monocytogenes: a model pathogen for farm-to-table intervention

324 Transmission of Listeria monocytogenes in the dairy food system, overview.

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Listeria monocytogenes not only causes a severe human foodborne disease, but also has been linked to infections in more than 20 different animal species. Animal listeriosis has particularly been reported in cattle, goats, and sheep; symptoms in these animals include meningitis, abortions, and septicemia as well as, less commonly, non-systemic infections such as uveitis and mastitis. Human listeriosis outbreaks involving a variety of dairy products (including butter, chocolate milk, Hispanic style cheeses) have been reported. According to the USDA/FDA Listeria risk assessment Hispanic style fresh cheeses represent a particular high risk food for acquiring listeriosis (on a per serving basis). L. monocytogenes strains also have a considerable ability to survive outside a mammalian host and under a variety of stress conditions, which represent a particular concern for the food industry. This organism has not only been shown to be present in most dairy processing plant environments, but specific strains of this organism have also been found to persist in processing plant environments for extended periods (up to months and years). While L. monocytogenes has been found in raw milk, current pasteurization time-temperature combinations effectively inactivate L. monocytogenes. Post-processing contamination from plant environments probably represents the most common source of L. monocytogenes contamination of pasteurized dairy products. Nevertheless, any point of the dairy food continuum may contribute to the presence of L. monocytogenes in dairy foods. Even for dairy products produced from pasteurized milk, L. monocytogenes present in raw materials or introduced from farm environments into processing plant on fomites (e.g., personnel) may indirectly contribute to finished product contamination. I will present a farm to table transmission model for L. monocytogenes, which will incorporate our current knowledge on the ecology and transmission of L. monocytogenes. Considerable gaps in this model will need to be filled before we can quantify the contributions of different potential sources in the dairy food continuum to finished product contamination at point of consumption.

Key Words: Listeria, Transmission, Food safety

325 Ecology and transmission of *Listeria monocytogenes* in ruminants and the farm environment.

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Listeria monocytogenes is an important human foodborne and animal pathogen. The interrelation of agent, host, and environmental factors such as strain virulence, host immuninty, and agricultural production practices, makes the epidemiology listeriosis difficult to elucidate. *L. monocytogenes* has been implicated as the causative agent in several large outbreaks of human foodborne illness. Thus, *L. monocytogenes* contamination of raw agricultural commodities used to produce foods that undergo minimal bactericidal processing (i.e. unpasturized dairy and ready-to-eat products) is a serious concern. The definitive source of *L. monocytogenes* in finished products is not clear. Because *L. monocytogenes* can infect food animals and survive in the environment for extended periods of time, *L. monocytogenes* may be carried through the food continuum by animals. Knowledge of *L. monocytogenes* transmission and ecology in pre-harvest food systems is needed to reduce contamination throughout the food chain. A case-control study was conducted to determine the prevalence and molecular epidemiology of *L. monocytogenes* in production ruminants, animal feed, and the farm environment (soil and water). Overall, *L. monocytogenes* was abundantly present in ruminant feces, animal feed, and the farm environment. While the prevalence of *L. monocytogenes* was not significantly different in bovine case and control farms, *L. monocytogenes* was significantly more common in small ruminant (caprine and ovine) case farms compared to controls. Therefore, the epidemiology of *L. monocytogenes* differs in small ruminant and bovine farms. Our data support an on-farm transmission model in which specific pathogenic *L. monocytogenes* subtypes in animals feeds are amplified in animals with or without clinical disease and dispersed into the farm environment. Cattle farms appear to maintain a large environmental *L. monocytogenes* load, including subtypes which have been linked to human listeriosis outbreaks. While we have established the presence of disease related *L. monocytogenes* subtypes on farms, the contamination source of animal-based foods which undergo listeriocidal heating steps is not known and requires further research.

Key Words: L. monocytogenes, Molecular epidemiology, Pre-harvest food safety

326 Human listeriosis outbreaks linked to dairy products: a European perspective.

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Dairy products have been implicated in approximately half of the reported listeriosis outbreaks in Europe. The listeriosis outbreaks have mostly been linked to consumption of raw milk or products produced from non-pasteurized milk. The outbreaks in Switzerland in 1983 to 1987 due to non-pasteurized soft cheese, the outbreak in Austria in 1986 related to non-pasteurized milk, and the outbreak in France in 1995 related to a brie-type cheese made of non-pasteurized milk demonstrate the risks involved with consumption of raw milk or soft cheeses made of non-pasteurized milk.

The pasteurization process of raw milk, which destroys *Listeria monocytogenes*, has not eliminated the risk of *L. monocytogenes* in dairy products. The outbreak in Finland from 1998 to 1999, with butter as the source, points out the fact that dairy products made of pasteurized milk may act as vehicles for *L. monocytogenes*. The post pasteurization equipment such as the packaging machine was contaminated with the outbreak strain elucidating the importance of post processing hygiene.

Extensive work has been done in several European countries during the last decade to the present day to prevent outbreaks and to decrease the incidence of listeriosis. This work has included preventive measures in the food processing plants, consumer advice, and early detection of outbreaks. The dairy processing plants have focused on improving the post processing hygiene and implementation of hazard analysis critical control programs, and the consumers belonging to the risk group have been informed about dietary risk factors. In fact, there has been a marked reduction in the incidence of listeriosis in some European countries during the last decade suggesting a relationship between the preventive measures and the reduction in listeriosis.

Several European countries have a national surveillance system with continuous genotyping of clinical strains which enables early detection of listeriosis outbreaks. The development of a common European surveillance program is in a planning stage. Such a program would give requisites for the recognition of multi-national outbreaks.

Key Words: Listeriosis, Dairy product, Outbreak

327 Control of *Listeria monocytogenes* in dairy processing plant environments. P. A. Hall*, *Kraft Foods - North America*.

Control of *Listeria monocytogenes*(LM) in processing plant environments is a multi-faceted approach requiring diligence and dedication throughout the entire organization. There are five elements that add up to effective LM control in a processing facility. The so-called Listeria equation consists of Traffic Patterns + GMPs + Dry, Uncracked, Clean Floors + Sanitary Design + Sanitation Procedures. A breakdown in any one of these elements can lead to an unacceptable risk of LM contamination in the plant environment and, ultimately, the finished product. Essential to effective LM control is a rigorous, aggressive environmental monitoring program. It is recommended that the genus Listeria be used as an indicator for LM and that a sufficient number of equipment and other sites be monitored (dependant on the size of the facility) on a weekly basis to ensure that the processing environment is under control. Incentive must be provided to plant personnel to aggressively find and eliminate LM in the environment. In order to ensure this, plant employees must must be provided with the proper tools and training, and the criticality of LM control must continuously be reinforced. This presentation will cover the key elements and specifics required to ensure effective LM control in dairy processing facilities.

Key Words: Listeria monocytogenes, Food safety, Environmental monitoring

328 The Listeria risk assessment: Dairy foods. S. Dennis*, J. Hicks, C. Carrington, and R. Whiting, *Food and Drug Administration, College Park, MD*.

The HHS/USDA *Listeria monocytogenes* risk assessment was issued in draft for public comment in January 2001. The purpose of the risk assessment was to systematically examine available scientific data and information to estimate the predicted relative risk of serious illness and death associated with consumption of ready-to-eat foods. The types of foods evaluated in the risk assessment include seafood, produce, dairy foods, meats, and deli salads. The dairy foods include five types of cheeses, milk, ice cream and other miscellaneous dairy products. This risk assessment is a tool that regulatory agencies can use to evaluate the effectiveness of current policies, programs, and regulatory practices. Using newly available data, information, and modeling techniques, the draft risk assessment will be revised in 2003. If the revised risk assessment is released before the meeting, the latest information on the predicted risks will be presented.

Key Words: Risk assessment, Listeria monocytogenes

Horse Symposium: Nutrient management

329 Knee deep in manure: what do horse owners do with it? L. K. Warren*, *Colorado State University, Fort Collins, CO USA*.

The average 455-kg horse produces 26 L of manure per day or 9.5 m^3/yr. When bedding material is added, the volume can easily exceed 20 m^3/yr per horse. How do horse owners manage all of this manure? The National Animal Health Monitoring System (NAHMS) Equine '98 Study found that approximately 11% of horse operations in the U.S. had manure removed from their property, 78% utilized or stored manure on-site, and the remaining 11% reported "other" means of disposal. Over half of the operations surveyed by NAHMS reported that the application of manure and stall waste on fields and pastures was the primary means of disposal. Those that allowed waste to accumulate or "left it to nature" made up 29% of the operations, and this practice was more likely to be employed when fewer horses were housed on the property. Hauling waste to a landfill or combining manure with household garbage for pickup was also more likely to be used as a disposal option with small, 1 or 2 horse operations. On-farm composting of horse manure was attempted by approximately 36% of those surveyed by NAHMS and was more prevalent in the northeast and western states. The increasing trend for horses to be housed on small, 1-35 acre "hobby" farms and in boarding stables means a larger number of horses are being housed on smaller parcels of land with less acreage available for spreading manure. Add to this greater restrictions on landfill dumping and the expense of hauling manure off-site and it becomes evident that horse owners are quickly losing waste disposal options. And simply "leaving it to nature" is not acceptable due to the risk of runoff and leachate from manure polluting watercourses and domestic water supplies. Educational programs are needed to inform horse owners about environmentally sound and neighbor-friendly waste management practices. In addition, markets must be found for horse waste or composted horse manure. And methods to reduce the waste stream (e.g., efforts to minimize bedding, feeding highly digestible feeds) should be investigated.

Key Words: Horse, Manure disposal, Waste management practices

330 Nutrient management regulations and the North Carolina equine industry. R. Mowrey*[1], [1]*North Carolina State University*.

In 1992, NC state regulations covering waste discharge required confined animal feeding operations above species based thresholds including equine operations with 75 or more head, to develop a waste management plan. Additional regulations developed by the Environmental Management Commission, govern surface water loading of nutrients in 3 of 17 NC river basins. The Tar-Pamlico River Basin (TPRB) nutrient management strategy requires agricultural operations to collectively achieve a 30% reduction in nitrogen from 1991,loading within a 7 year period. The N.C. Horse Council-Environmental Issues Committee (NCHC-EIC) monitors development of nutrient management regulations, recommends best management practices (BMP's) to control nutrient loading and serves as the horse industry liaison working with government agencies. Current recommended TPRB regulations require horse operations with 20 or more head to participate in a pasture point system based on pasture BMP's. The NCHC-EIC assists in development of BMP's with pre-assigned point values. Producers who implement BMP's will earn points. When BMP's are implemented and a required point total is reached, producers will be exempt from additional nutrient management efforts. Potential BMP's include exclusion from water sources, non-fertilizer zones, alternate water sources and dietary nutrient management. A lack of equine research data to support BMP's has hindered the approval process. The NCSU Animal Science and Biological Engineering Departments received FY 2003 to 2005 grant funding from the U.S. Environmental Protection Agency to conduct manure and pasture management educational programs. A series of producer educational conferences and field days will demonstrate BMP's on horse farms that improve water quality. The project will be implemented with the assistance of Regional Equine Information Network System volunteers in multi-county areas. Demonstrations will focus on developing and testing improved animal crop and waste management systems to provide maximum environmental protection. This information will be essential to support the development of future equine BMP's to enhance water quality.

Key Words: Equine, Pasture management, Water quality

331 Potential impact of new Concentrated Animal Feeding Operation regulations on the equine industry. D. R. Topliff*, *West Texas A&M University*.

The new regulations from EPA concerning the definition of Animal Feeding Operations (AFO) and regulation of certain AFOs as Concentrated Animal Feeding Operations (CAFO) have been finalized. These new regulations contain provisions that have potentially serious consequences for the horse industry. EPA has adopted a three-tiered plan for regulation of CAFOs that classify them as Large, Medium, or Small and places the number of confined horses necessary to qualify for a particular status at 500 and 150 for the first two categories and authority of regional directors to specify operations for the third. Any AFO that discharges pollutants directly into the waters of the U.S. or has animals in direct contact with waters of the U.S. may be designated as a CAFO regardless of the number of animals confined. Data was provided to EPA from the