

in this study were of similar availability when offered in molasses supplements. A dietary Cu concentration greater than 10 ppm might be necessary to ensure absorption in beef cattle fed molasses-based supplements.

Key Words: Cattle, Copper, Molasses

314 Evaluation of Na requirements for finishing feedlot heifers. C. B. Wilson*, G. E. Erickson, C. N. Macken, and T. J. Klopfenstein¹, ¹University of Nebraska, Lincoln, NE.

A trial was conducted to evaluate the effects of increasing levels of salt (NaCl) inclusion on animal performance and feed intake. The objective of this trial was to establish a NaCl level and Na requirement that maximizes intake and performance while minimizing excretion of Na to the environment. Fifty-nine head of individually fed yearling heifers (365 kg) were assigned randomly to treatment and fed for 113d. Heifers were adapted to concentrate on treatment diets by increasing intake (0.23 kg/d) from 1.5 % of BW until ad libitum consumption was attained, approximately 21 d. The diet included 42.5% high moisture corn, 42.5% dry rolled corn, 7.5% grass hay, 3% tallow and 5% supplement. Five treatments (12 hd/trt) were formulated to include increasing levels of NaCl in the supplement at 0, 0.125, 0.25, 0.375 and 0.5 % of diet DM. Treatments bracketed 1996 National Research Council (NRC) minimum Na requirements (0.08% of DM). Water intake was measured using water meters on a group basis to evaluate additional Na intake. Ingredient and water analysis showed increasing levels of Na intake from 3.0, 7.0, 11.0, 14.7 and 19.3 ± 0.38 g/heifer/d with an average of 1.9 g/d from water. Analyzed Na levels in the diet were 0.03, 0.07, 0.11, 0.16 and 0.20 % of DM. Analysis of performance data showed no significant difference in ADG, DMI or gain:feed (G:F) with different levels of NaCl. Overall, NaCl supplementation was not effective in increasing ADG, G:F or DMI. Heifer performance averaged 1.46 ± 0.06 kg/d ADG with G:F averaging 0.150 ± 0.004. No significant effects were detected for fat, marbling or yield grade ($P > 0.10$) data across all treatments. These results suggest that NaCl inclusion in diets is not necessary, and the Na requirement is less than current NRC recommendations. Feedlot operations may reduce the excretion of Na to the environment and help to make feeding cattle more environmentally sustainable (i.e. minimizing Na buildup in acres receiving manure and runoff water).

Key Words: Salt, Sodium requirement, Feedlot cattle

315 Effect of feeds naturally high in selenium on performance and selenium concentration in various tissues of finishing beef steers. T. L. Lawler*¹, J. B. Taylor², J. W. Finley³, and J. S. Caton¹, ¹North Dakota State University, Fargo, ND, ²USDA-ARS, Dubois, ID, ³USDA-ARS, Grand Forks, ND.

A majority of the human daily requirement of selenium (Se) can be obtained from beef. Although Se content of edible beef tissue is highly variable, previous research suggests that this content can be influenced by the concentration and form of Se in feedstuffs consumed. Data are limited describing effects of feeds high in Se on performance and tissue Se concentration of finishing beef steers. Therefore, 45 beef steers (BW = 351.1 ± 24.1 kg) were assigned to one of four treatments: Se adequate (CON; n = 12), or high Se provided as high Se wheat (WHT; n = 11),

high Se hay (HAY; n = 11), or sodium selenate (SEO; n = 11). Selenium content for WHT, HAY, and SEO diets was 65 g·kg⁻¹ BW·d⁻¹, and for CON, 9.5 g·kg⁻¹ BW·d⁻¹. Kidney, pelvic, and heart fat was higher ($P = 0.06$) among CON and WHT compared to SEO and HAY (2.9, 2.9, 2.4, 2.5 0.2%, respectively); other performance measures were not affected ($P > 0.01$). Concentration of Se in kidney and spleen was different ($P < 0.01$) in response to treatment with WHT > HAY > SEO > CON (12.98, 10.86, 10.05, 8.40 0.26 ppm for kidney and 5.16, 3.82, 2.60, 2.00 0.09 ppm for spleen; respectively). Liver samples contained 10.79, 9.91, 6.56, 2.33 0.80 ppm Se where WHT = SEO > HAY > CON, respectively ($P < 0.01$). Selenium content of the muscle was much greater ($P < 0.01$) in treatments containing feeds naturally high in Se (WHT > HAY > SEO = CON; 4.41, 3.32, 1.55, 1.33 0.18 ppm, respectively). In conclusion, producers can effectively increase selenium concentration in muscle tissues by feeding feedstuffs naturally high in Se without compromising performance or carcass characteristics. These results reveal a potential market for feeds naturally high Se through the provision of a readily available Se source to cattle, and an effective method to create a beef product that is naturally high in Se.

Key Words: Beef, Wheat, Natural

316 Effect of total dissolved solids and sulfates in drinking water for growing steers. H. H. Patterson, P. S. Johnson, and W. B. Epperson, South Dakota State University, Brookings, SD.

Previous data from our laboratory showed that water with elevated total dissolved solids (TDS) and sulfates was detrimental to performance and health of growing steers. The objective of this study was to determine the level of TDS or sulfates where reductions in performance and health occur. Eighty-four crossbred steers (290 kg) were blocked by weight and randomly assigned to one of 12 pens (7 steers/pen). Pens were randomly assigned to one of four water treatments (3 pens/treatment) based on TDS and sulfate concentrations (mg/L): 1) 1150 TDS (385 sulfates); 2) 2800 TDS (1815 sulfates); 3) 4800 TDS (3000 sulfates); and 4) 7500 TDS (4800 sulfates). All water was obtained from natural sources and constituted the only available water source. Steers were fed a diet (0.97 Mcal/kg NEg) of ground grass hay and wheat middlings from May 23 to September 4 (104 days). Compared to 1150 TDS water, steers on 4800 TDS water had lower ($P = 0.08$) body weights at study end. Steers receiving 7500 TDS water had lower ($P = 0.001$) ending weights than all other treatments. Average daily gain and dry matter intake declined quadratically (each $P = 0.02$) with increasing TDS level (0.81, 0.75, 0.67, and 0.28 kg/d and 9.43, 9.35, 8.59, 5.98 kg/d for ADG and DMI on 1150, 2800, 4800, and 7500 water, respectively). Gain/feed declined quadratically ($P = 0.04$) with increasing TDS level. Incidence of polioencephalomalacia was 48% in the 7500 treatment with no cases in any other treatment ($P = 0.0001$), and 33% of steers on the 7500 treatment died of polioencephalomalacia ($P = 0.0001$). Water with 4800 mg/L TDS and 3000 mg/L sulfates tended to cause performance reductions in growing steers, whereas water with 7500 mg/L TDS and 4800 mg/L sulfates caused marked reductions in steer performance and health. These data, combined with field observations, suggest that water quality in a significant portion of South Dakota may be insufficient for optimal production.

Key Words: Water quality, Polioencephalomalacia, Performance

Dairy Foods Symposium: Hispanic-Style Cheeses

317 Overview of Hispanic cheese. N. Y. Farkye*, Dairy Products Technology Center, California Polytechnic State University, San Luis Obispo, CA.

The growth of Hispanic population in the U.S.—31.3 million in 2000 (i.e., 11.9% of the U.S. population) and the increased interest in ethnic foods has resulted in an increased demand for Hispanic cheeses. Between 1997 and 2002, Hispanic cheese production in the U.S. grew over 70% from 68.8 million lb to 117.5 million lb. Queso Fresco (pronounced Keh-so Fres-co) is the most popular variety with a finely milled and crumbly texture. Panela (Pah-neh-la) has a basket-weave appearance. Average composition of Queso Fresco is 49% moisture, 22.5% fat, 21.5% protein, 2.0% salt and pH of 6.3; and Panela contains 50% moisture, 23% fat, 20% protein, 1.6% salt and pH of 6.3. Cotija (Ko-tee-hah) is hard and crumbly, similar to young Parmesan and contains 37% mois-

ture, 27% fat, 26% protein, 4% salt and pH 5.5. Oaxaca (Wa-ha-ka) is a 'pasta filata' variety similar to Mozzarella with an average composition of 45% moisture, 24% fat, 23% protein, 1.7% salt and pH of 6.0. Asadero (Ah-sah-deh-ro) contains 45% moisture, 21% fat, 24.5% protein, 1.7% salt and pH 5.6. Asadero may contain emulsifying salts, hence its high meltability. Other Hispanic cheeses are Queso Blanco (Keh-so Blan-co); Queso Para Freir, Queso Aejo (Keh-so An-ye-ho), meaning 'aged cheese'; Queso Enchilado (Keh-so En-chee-la-do) which is essentially Queso Fresco with a coating of paprika or chili powder; Queso Chihuahua (Keh-so Chee-wah-wah), also called Mennonita or Queso Quesadilla is a hard to semi-hard variety similar to Cheddar or Jack; Queso Crema which is similar to Panela but has a higher fat content; and Requeson which is similar to ricotta.

Key Words: Hispanic cheese

318 The growing Hispanic cheese market and distribution. R. Poe*, *Sequoia Valley.*

The Hispanic consumer is a significant market segment in the USA. Current Hispanic population in the U.S. is 34.8 million and it is expected to grow to 13.3% of the U.S. population by 2005. The demand for Hispanic cheeses is no longer regional but national. Cheese is an integral part of an average Hispanic meal—with queso being used as a staple or filler. Distribution of Hispanic cheeses is primarily in “bulk”. Customers always want to taste the product prior to purchase, and then purchase by weight. Pre-packaged cheese is less than 10% of volume. In the U.S., about 90% of “bulk” Hispanic cheeses are delivered by Direct Store Delivery (DSD) to Carnicerias (mom and pop stores). However, the growth of pre-packaged cheeses is expanding rapidly due to retail chains recognizing the growth of Hispanic cheeses. Hence, the newest trend of distribution is through Retail Chain Distribution Centers and/or Master Distributors. Current distribution and marketing trends will be discussed.

Key Words: Hispanic cheese, Marketing, Distribution

319 Starter cultures for Hispanic-style cheeses: The case of Queso-Fresco. B. Vallejo-Cordoba*, M. J. Torres-Llanez, M. A. Mazorra-Manzano, and A. F. Gonzalez-Cordova, *Centro de Investigacion en Alimentacion y Desarrollo, A. C., Hermosillo, Sonora, Mexico, 83000.*

Queso Fresco is characterized by being high in moisture content, having a mild flavor and a short shelf-life. It is also the most popular Hispanic-style cheese consumed in Mexico and the United States. Traditionally, Queso Fresco is made from raw milk; however, its high moisture content, near neutral pH and absence of starter cultures makes this cheese an unsafe product. To solve this problem, an alternative would be to produce Fresco cheese from pasteurized milk using non-specific starters. However, the use of such starters means that the organoleptic quality of the product bear little relation to those of its traditional counterpart. There is thus increasing interest in the development of specific indigenous starters for use in the manufacture of traditional-type cheeses that would allow the making of a uniform safe product of constant quality. The objectives of this work are to present the design of specific starter cultures for the production of Queso Fresco. Additionally, the use of non-specific commercial starter cultures utilized in the manufacture of the most popular Hispanic-style cheeses consumed in Mexico will be discussed. Four cheese batches were prepared following traditional practices. Physiological and biochemical characteristics of native lactic acid bacteria isolated from the cheese were studied for their identification and inclusion in the specific starters. Cheeses were made by using pasteurized milk and six different starters and their flavor and texture were compared with the traditional cheese. Queso Fresco made with specific starter cultures were not significantly different ($p > 0.01$) from the traditional cheese made from raw milk. Queso Fresco made from pasteurized milk and specific starters, allowed the making of a uniform safe product of organoleptic qualities equivalent to its traditional counterpart.

Key Words: Starter cultures, Hispanic-style cheeses, Fresco cheese

320 Effect of fatty acid modification to lower saturates on quality of Queso Blanco. S. O'Keefe* and A. Aigster, *Virginia Tech Department of Food Science.*

Nutritional recommendations to lower consumption of saturated fat often lead to reduced consumption of dairy products, including cheese. Dairy products with fatty acid compositions with lower saturates and higher monoenes would have clear health benefits for consumers. Queso blanco is a Hispanic, acid-set cheese which is non-melting and has a very short production time. Experiments were conducted to investigate the effects of milk fatty acid modification, to increase monounsaturates and lower saturates, on texture, sensory properties and oxidative stability of queso blanco prepared using acetic acid. Milk with modified fatty acid composition was obtained by feeding calcium salts of high oleic sunflower oil. Oleic acid was increased from 26% to 40% and the oleic to palmitic acid ratio increased from 1.0 to 2.0 after modification. There was no measurable effect of modification on texture of cheese as determined using an Instron. Sensory panels indicated that acceptability was similar between normal and modified cheese and storage stability testing showed similar levels of oxidation after storage. Queso blanco prepared

using milk modified to have high oleic and low saturated fatty acid compositions has similar texture, sensory and stability to traditional cheese.

Key Words: Queso blanco, Monoene, Cheese quality

321 Crumbliness of Queso Fresco. S. Gunasekaran*, *University of Wisconsin-Madison.*

The Queso Fresco is one of the most common Latin American white cheeses that has a unique crumbly texture. Queso Fresco is crushed and sprinkled on foods and then consumed. The cheese maintains its integrity under heat. Therefore, it is ideal for casseroles, Mexican specialties such as enchiladas, quesadillas, tacos and other dishes that are broiled or baked before serving. Since Latin American cheeses are new for mass manufacturing in the U.S., evaluation of major textural characteristics has not been widely performed. The crumbliness of Queso Fresco-type cheeses may be defined as a “measure of how readily the cheese can be fragmented into small particles suitable for even spreading.” Currently, crumbliness is measured subjectively. We have developed an objective instrumental method to measure crumbliness in comparison to sensory evaluation. The instrumental tests we investigated include texture profile analysis, uniaxial compression, and shear. The samples crushed in the compression tests were subsequently subjected to particle analysis to estimate total number of crumbled particles. Statistical correlations were obtained using ANOVA with Tukey multiple comparison between the sensory parameters (firmness, moistness, crumbliness, particle size, particle size uniformity) and instrumental-test parameters (hardness, toughness, modulus, fracture stress, fracture strain, number of particles, etc.). The sensory perception of crumbliness, described as the ease of fragmenting the cheese, was used as the primary indicator defining the cheese crumbliness. Among the many properties measured, total number of particles determined from particle analysis correlated the best with sensory crumbliness.

Key Words: Queso fresco, Crumbliness, Particle size

322 Cheeses from different countries of Latino America. V. Alvarez*¹ and R. Jimenez-Flores², ¹*The Ohio State University,* ²*DPTC-California Polytechnic State University.*

Latino American (LA) countries have a rich tradition in the production and consumption of cheese, which is called “Queso” and “Queijo” in Spanish and Portuguese, respectively. Cheesemaking in LA region started when the Spanish and Portuguese conquerors brought the first herds to the American continent. Therefore, all cheeses made in LA were originally developed following European cheesemaking procedures. There is a wide variety of cheese products found from the north of Mexico to the south of Argentina due to vast differences in climate, agricultural practices and traditions. LA cheeses can be soft, semi-hard and hard. As in other countries of the world, cheeses are named for the town, region or community in which they are made, thus many cheeses with different names might have practically the same textural and flavor characteristics. Some well known cheeses from LA are queso Añejo, Panela, Cotija, Oaxaca, tipo Manchego from Mexico; fresh cheeses made with whole or partially skimmed milk and pressed are called Queso Prensa, in El Salvador and Venezuela, Queso de Puna in Puerto Rico, Queso Estera in Colombia and Queso Descremado in Costa Rica. Other recognized LA cheeses are Queso Colonia in Uruguay; Queijo Prato (Prato cheese), Requeijao and Minas Frescal in Brazil; Mar de Plata, Mantecoso and Parmesan in Argentina. The important characteristics and processing of these LA cheeses and their relationship with the Hispanic cheeses found in the U.S. market will be reviewed and discussed.

Key Words: Cheese, Queso, Latino America

323 Functional and rheological attributes of Hispanic-style cheeses. D. L. Van Hekken*¹, M. H. Tunick¹, D. W. Olson¹, F. J. Molina-Corral², A. A. Gardea², and P. M. Tomasula¹, ¹*USDA, ARS, Eastern Regional Research Center,* ²*Centro de Investigacion en Alimentacion y Desarrollo, Cuauhtemoc, Mexico.*

The range of functional and rheological properties of the many styles of Hispanic cheeses arise from variations in their composition and methods used to process them. However, limited information is available on these cheeses. The objective of this joint ERRC-CIAD study was to characterize the compositional (moisture, fat, protein, salt), physical (pH, water activity), functional (color change upon heating, meltability), and

rheological (hardness, springiness, cohesiveness, chewiness, elastic and viscous modulus, torsion shear stress and shear strain) properties of soft (Panela, Queso Fresco), semi-hard (Mexican Monnonite, 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. M. Wiedmann*, Cornell University, Ithaca, NY.

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. K. K. Nightingale*, E. D. Fortes, C. R. Nightingale, Z. Her, Y. H. Schukken, Y. T. Grohn, and M. Wiedmann, Cornell University.

Listeria monocytogenes is an important human foodborne and animal pathogen. The interrelation of agent, host, and environmental factors such as strain virulence, host immunity, 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. unpasteurized 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. J. Lunden* and H. Korkeala, Helsinki University, Helsinki, Finland.

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