was developed. The statistical distances among the breeds, populations and individuals are the genetic or breeding differences which can be used to multiple breeds genetic evaluations.

Key Words: Mixture distribution, Statistical distance, Multiple breed

42 Use of Principal Components and Factor Analysis to factorize genetic correlation matrices of multivariate phenotypes. N. P. P. Macciotta*, N. Bacciu, C. Dimauro, and A. Cappio-Borlino, *Dipartimento di Scienze Zootecniche, Università di Sassari*, *Sassari, Italia*.

Principal Component Analysis (PCA) has been used by several authors to address issues of genetic analysis of multivariate complex phenotypes, i.e. large number of parameters to be estimated, computational constraints and sampling error. PCA is able to describe the maximum amount of original variation with the minimum number of orthogonal new variables. However, it is scarcely flexible and results are not always easy to interpret. In order to cope with these shortcomings, the multivariate Factor Analysis (FA) could be proposed. FA, via the rotation technique, is able to extract latent variables with defined relationships with original variables. In the present work the ability of PCA and FA to factorize genetic correlation matrices (published data) of milk yield, logSCC for dairy cattle and weights at different ages for beef cattle is compared. The PCA yields a first component related to all original variables, able to explain most of the original variance (82%, 50%, 82% for milk yield, logSCC and body weight, respectively). Other principal components highlight the contribution of specific original variables to the total variance in decreasing order. On the other hand, FA extracts common latent factors related to specific groups of variables and that have a clear biological meaning: in the case of milk yield, for example, the fist latent common factor is able to explain 55% of the original variance, it is related to the milk tests of the second part of lactation and can be considered as an index of lactation persistency; the second factor (42% of explained variance) is related with tests of the first part of lactation and can be considered as an index of level of production in early lactation. Similar results are obtained for body weights and, even if less defined, for logSCC. Results of the present work suggest that a combined used of PCA and FA could be usefully for a deep understanding of latent structure of correlations in multivariate complex phenotypes.

Key Words: Multivariate phenotypes, Principal component analysis, Factor analysis

Food Safety: Ruminants as Reservoirs for Shiga Toxin-Producing Escherichia coli

43 Shiga toxin-producing *Escherichia coli*: The big picture. C. L. Gyles*, *University of Guelph*, *Guelph, Ontario, Canada*.

Shiga toxin-producing *Escherichia coli* (STEC) represent a diverse group of *E. coli* that have one thing in common, namely, the ability to produce Shiga toxin (Stx). STEC behave as normal flora in ruminants, which are a major reservoir. In humans, STEC can cause disease of varying severity. Serotyping is used as an initial basis for differentiating STEC, and virulence characteristics that are serotype-related have allowed the concept of sero-pathotype to be developed. Serotype O157:H7 is the serotype that is most frequently implicated in outbreaks of disease and in severe disease in North America and several other regions. This serotype has therefore been the subject of the most intense investigation both with respect to its relation to its reservoir host, ruminants, and its accidental host, humans. Other serotypes are also implicated in outbreaks and in severe disease. STEC pathogenesis involves two phases: colonization of the intestine, and production of toxin. Several approaches have been used in attempts to identify the bases for virulence of STEC. These have resulted in recognition of a large number of putative virulence factors, but only a small number are clearly significant contributors to virulence. Most of the highly pathogenic STEC have the ability to produce a characteristic attaching and effacing lesion in the intestine. This lesion is the result of a bacterial type III secretion system that injects certain effector proteins into the host intestinal epithelial cell. Profound changes in the architecture and metabolism of the host cell occur and contribute to the diarrha that develops. The severe complications that develop in a certain percentage of affected humans are attributable to the Shiga toxin, which exists as two major types, Stx1 and Stx2. STEC may produce one or both of these types of Stx. Production of Stx2 is associated with disease of greater severity, but strains that produce Stx1 may also cause severe disease. The genes for Stx are encoded on temperate bacteriophages in the chromosome of the bacteria and production and release of the toxin are highly dependent on induction of lysis of the phages.

Key Words: Serotype, Virulence, Shiga toxin

44 Prevalence and pathogenicity of Shiga toxin-producing *Escherichia coli* in beef cattle and their products. H. S. Hussein*, *University of Nevada*, *Reno*.

In the past 25 years, many human illness outbreaks have been traced worldwide to consumption of undercooked ground beef and other beef products contaminated with Shiga toxin-producing *Escherichia coli* (STEC). Because of the global nature of food supply, the safety concerns with beef will continue and the challenges facing the beef industry will increase. To be prepared to address these concerns and challenges, it is critical to assess the beef cattle role in human infection with STEC. Because most STEC outbreaks in the US were traced to beef containing *E. coli* O157:H7, the epidemiological studies have focused on prevalence of this serotype in beef cattle. Worldwide, however, additional STEC serotypes (e.g., members of the O26, O91, O103, O111, O118, O145, and O166 serogroups) have been isolated from beef and caused human illnesses ranging from bloody diarrhea and hemorrhagic colitis to the life-threatening hemolytic uremic syndrome (HUS). To provide a global assessment of the STEC problem, published reports on beef and beef cattle in the past three decades were evaluated. Prevalence rates of *E. coli* O157 ranged from 0.1 to 54.2% in ground beef, from 0.1 to 4.4% in sausage, from 1.1 to 36.0% in various retail cuts, and from 0.01 to 43.4% in whole carcasses. The corresponding prevalence rates of non-O157 STEC were 2.4 to 30.0%, 17.0 to 49.2%, 11.4 to 49.6%, and 1.7 to 58.0%, respectively. Of the 161 STEC serotypes isolated from beef products, 43 were detected in HUS patients and 36 are known to cause other human illnesses. With

regard to beef cattle, prevalence rates of *E. coli* O157 ranged from 0.3 to 19.7% in the feedlot and from 0.7 to 27.3% on pasture. The corresponding prevalence rates of non-O157 STEC were 4.6 to 55.9% and 4.7 to 44.8%, respectively. Of the 350 STEC serotypes isolated from cattle feces or hides, 63 were detected in HUS patients and 61 are known to cause other human illnesses. The results indicated prevalence of a large number of pathogenic STEC in beef cattle and their products at high rates and emphasized the critical need for control measures to assure beef safety.

Key Words: Food safety, *Escherichia coli*, Beef cattle

45 Pre-harvest control of *Escherichia coli* O157. J. T. LeJeune* and A. N. Wetzel, *The Ohio State University*, *Wooster*.

Bovine manure is an important source of *Escherichia coli* O157 contamination of the environment and foods; therefore, effective interventions targeted at reducing the prevalence and magnitude of fecal *E. coli* O157 excretion by live cattle (pre-harvest) is desired. Pre-harvest intervention methods can be grouped into three approaches: (1) exposure reduction strategies; (2) exclusion strategies; and (3) direct anti-pathogen strategies. Exposure reduction involves environmental management targeted at reducing bovine exposure to *E. coli* O157 through biosecurity and environmental niche management such as feed and drinking water hygiene, reduced exposure to insects or wildlife, and the condition of the bedding, or pen floor. In the category of exclusion, we group vaccination and dietary modifications such as, selection of specific feed components, in-feed delivery of prebiotics, probiotics, and competitive exclusion cultures-all strategies that would theoretically limit the proliferation of *E. coli* O157 in or on the live animal following exposure. Direct anti-pathogen strategies are those that are intended to be bacteriocidal to *E. coli* O157 in or on cattle. This includes treatment with chemicals (sodium chlorate, antibiotics), bacteriophages, or physical washing of animals pre-slaughter. Presently, only one pre-harvest control for *E. coli* O157 in cattle has been demonstrated repeatedly to be effective and gained widespread adoption (the feeding probiotic *Lactobacillus acidophilus*). Progress is being made in the direction of pre-harvest control strategies in cattle. More research into the effectiveness of parallel and simultaneous application of one or more pre-harvest control strategies, as well as the identification of new pre-harvest control techniques, may provide practical means to substantially reduce the incidence of human *E. coli* O157-related illnesses by intervening at the farm level.

Key Words: *E. coli* O157, Pre-harvest, Food safety

Forages and Pastures: Quality and Antiquality

46 The biochemistry of tannins: Role in ruminant production. J. Foster*, *USDA, ARS, Appalachian Farming Systems Research Center*, *Beaver, WV*.

Tannins are high molecular weight, water-soluble polyphenols that form reversible complexes with proteins through pH-dependent hydrogen bonding and hydrophobic interactions. Hydrolyzable tannins (HT) contain a carbohydrate core esterified with gallic or hexahydroxydiphenic acid. Binding of HT to abomasal mucosal proteins causes lesions that result in diarrhea or constipation. Hydrolytic products of HT are absorbed from the small intestine, disrupt liver and kidney function, and may cause photosensitization and dehydration. Condensed tannins (CT) or proanthocyanidins are oligomers of flavan-3-ols or flavan-3,4-diols that are linked by C-4/C-8 or C-4/C-6 interflavan bonds. Variations in chemical reactions of CT arise from differences in monomeric constituents, interflavan bond type, polymer length and branching, molecular weight, and concentration. High concentrations of CT in ruminant diets result in formation of stable, insoluble complexes with digestive enzymes and proteins in feed, saliva, and microbial cells, decreasing feed intake and digestibility and increasing fecal N excretion. Complexation of metal ions by CT can result in microbial mineral deficiencies. Protection against the negative effects of CT is provided by proline-rich salivary proteins in some ruminants and can be achieved with polyethylene glycol supplements which disrupt tannin-protein complexes. At low concentrations, CT decrease proteolysis of dietary proteins, rumen ammonia production, and rumen bacterial biomass, and increase N flow to the abomasum and absorption of essential amino acids in the small intestine. Results include increased animal weight gain; improved fiber, meat, and milk production; and higher ovulation rate. Protein-CT complex formation also reduces rumen gas formation and prevents production of a stable foam in the rumen, alleviating bloat in ruminants consuming protein-rich diets. Anthelmintic properties of CT in ruminants are associated with improved nutrient supply to the lower gastrointestinal (GI) tract. Positive effects of CT on GI nematode parasites include lower fecal egg counts, decreased worm burdens, and inhibition of egg hatch and larval development.

Key Words: Tannins, Nutrient utilization, Herbal anthelmintic

47 Polyphenols and mechanical maceration shift protein fractions in legume hays from rapidly to slowly degraded forms. J. H. Grabber*, *USDA-Agricultural Research Service, US Dairy Forage Research Center*, *Madison, WI.*

Rapid proteolysis of forage protein during rumen fermentation can impair protein use by dairy cattle. The severity of conditioning at harvest may influence protein degradability in forages, particularly if protein-binding polyphenols are present. In 2002 and 2003, first and second cuttings of alfalfa, red clover with o-diphenols and polyphenol oxidase, and three birdsfoot trefoil populations with low to high tannin levels were conventionally conditioned with rolls or macerated and then dried as hay. Forage protein was partitioned with buffer and detergent solutions into rapidly (AB1), moderately (B2), and slowly (B3) degraded and undegradable (C) fractions. Treatment differences noted below were significant at the 0.05 level. Averaged over years and harvests, crude protein averaged 222 g/kg for alfalfa and 207 g/kg for trefoils and clover. Protein in roll conditioned alfalfa was comprised of 440 g/kg of AB1, 451 g/kg of B2, 75 g/kg of B3, and 34 g/kg of C. The high tannin trefoil had 64 g/kg less AB1, 59 g/kg more B2, similar B3, and 7 g/kg more C than alfalfa. Red clover had 107 g/kg less AB1, 40 g/kg more B2, 68 g/kg more B3, and similar C compared to alfalfa. Shifting from roll conditioning to maceration decreased AB1 by an average of 115 g/kg in all forages. Maceration increased B2 by 53 g/kg in alfalfa, decreased B2 by 41 g/kg in red clover, and had no effect on B2 in high tannin trefoil. Maceration increased B3 by 63 g/kg in