

**678 Biological considerations pertaining to use of the retinal vascular pattern for permanent identification of livestock.** J. C. Whittier<sup>\*1</sup>, J. Doubet<sup>2</sup>, D. Henrickson<sup>2</sup>, J. Cobb<sup>2</sup>, J. Shaddock<sup>2</sup>, and B. L. Golden<sup>1,2</sup>, <sup>1</sup>Colorado State University, <sup>2</sup>Optibrand, Ltd LLC.

Our objective was to characterize the retinal vascular pattern (RVP) as a stable biomarker for use in identification of livestock. The central retinal artery and vein enter the eye along the optic nerve and divide to supply the retinal surface. The geometric configuration of this vascular bed develops and is completed during fetal growth as vasculogenesis and angiogenesis occur. Other authors have reported that retinal angiogenesis is a Laplacian process which is ubiquitous in nature and follows branching patterns seen in rivers, trees, roots, and erosion channels. RVP images from livestock can be converted into a quantifiable format using a digital camera. Indexes can be created from the patterns resulting from a hashing function to allow rapid one-to-many searching. The number and position of branches, along with the diameter of each

vessel combine to offer an information rich biomarker for use in animal identification. To evaluate each RVP the dominant trunk vessel of bovine RVP images was positioned vertically and branches on the right and left of the trunk and other branching points were counted. RVP images from 52 different cattle were evaluated. Branches from the left (LB=6.4, 2.2; mean, variance) and right (RB=6.4, 1.5) of the vascular trunk; total branches from the vascular trunk (TBVT=12.8, 4.3), and total branching points (TBP=20.0, 13.2) showed differences across animals. A paired comparison of RVP from both eyes of 30 other animals confirmed that eyes from the same animal differ. RVP images of 4 cloned sheep from the same parent line were evaluated to confirm the unique RVP in genetically identical animals. The uniqueness of the RVP allows for the unalterable association of animal with owner and premises improving the reliability of processes such as contaminated product recall, disease epidemic containment, and subsidy payment schemes.

**Key Words:** Retinal vascular pattern, Animal identification, Biomarker

## Ruminant Nutrition: Minerals and vitamins

**311 Role of trace minerals and vitamins in optimizing immune function of cattle.** E. B. Kegley<sup>\*</sup>, University of Arkansas, Fayetteville.

The immune system is a complex, multi-faceted response to challenge. Dysfunctions of this system result in significant annual losses to livestock producers; problems may, in part, be addressed by nutritional intervention. Enhancing the immune response through optimizing nutrition is a goal receiving increasing emphasis. Specifically, trace mineral and vitamin status alter various components of the immune system and will be the subject of this review. Research results indicate that trace minerals; including: Zn, Cu, Se, Cr, and Co; and vitamins E and A; impact immunocompetence. Many of these micronutrients have antioxidant activities that benefit animal health. Zinc plays a major role in disease resistance and immune responsiveness of many species. In lab animals, Zn deficiency impairs thymus activity, natural killer cell and neutrophil function, and cytokine production. Yet, research in ruminants has been more variable. Severe Zn deficiency impacts lymphocyte function and wound healing. In dairy cattle, high levels of supplemental Zn are generally associated with reduced somatic cell counts, possibly reflecting the importance of Zn in maintaining effective epithelial barriers. Copper and Se status affect several aspects of the immune system. In vitro, neutrophils isolated from ruminants deficient in Cu or Se have reduced ability to kill ingested bacteria, part of nonspecific immunity. Studies with ruminants indicate little effect of Cu deficiency on specific immune function. In contrast, supplemental Se has enhanced ruminant antibody response. Selenium deficiency is correlated with increased incidence of metritis and clinical mastitis in dairy cows. Supplemental vitamin E decreases morbidity in stressed calves. Research continues to determine the optimal concentrations and sources of micronutrients in the diets of ruminants, considering that dietary requirements for optimizing immune function may be greater than those needed for maximal growth or reproductive performance, and may be greater during periods of physiological stress.

**Key Words:** Trace minerals, Vitamins, Cattle

**312 Incidence of bovine respiratory disease in receiving heifers: effects on weight gain and carcass characteristics.** S. P. Montgomery<sup>\*</sup>, J. S. Drouillard, J. J. Sindt, M. A. Greenquist, W. F. Miller, J. N. Pike, E. J. Good, E. R. Loe, M. J. Sulpizio, and T. J. Kessen, Kansas State University.

Crossbred beef heifers (n = 665, BW = 225 ± 24 kg) were used in a completely randomized design to determine the effects of bovine respiratory disease (BRD) on ADG and carcass characteristics. Heifers were processed within 24 h of arrival and processing included vaccination against common viral and clostridial diseases, recording of rectal temperature, and measurement of plasma glucose and lactate concentrations. Heifers were subsequently monitored for clinical signs of BRD including depression, lethargy, anorexia, coughing, rapid breathing, and nasal or ocular discharge. Heifers exhibiting signs of BRD received antibiotic therapy and the number of times a heifer was treated for BRD was recorded and ranged between zero and three. Following the 36-d receiving period heifers were allowed to graze native range for 136 d and then transported

to a commercial feedyard where they were fed a common series of diets throughout a 124-d finishing period. Plasma glucose and lactate concentrations measured at time of initial processing were greater (P < 0.1) for heifers not treated for BRD than the mean of heifers subsequently treated for BRD, and decreased (linear, P < 0.01) as treatment for BRD increased. Rectal temperature measured at time of initial processing increased (linear, P < 0.03) with increased treatment for BRD. Initial BW, ADG, and final BW during the receiving period decreased (linear, P < 0.01) as treatment for BRD increased, while grazing period ADG was increased (linear, P < 0.01). Finishing period ADG, final BW, hot carcass weight, fat thickness, and marbling score were decreased (linear, P < 0.05) with previous incidence of BRD. These data suggest that initial plasma glucose and lactate concentrations may be indicative of health status of newly arrived receiving cattle and that increased incidence of BRD in cattle decreases ADG and carcass quality.

**Key Words:** Health, Daily gain, Carcass quality

**313 Effect of copper source and level on performance and copper status of cattle consuming molasses-based supplements.** J. D. Arthington<sup>\*1</sup>, F. M. Pate<sup>1</sup>, and J. W. Spears<sup>2</sup>, <sup>1</sup>University of Florida - IFAS, Ona, <sup>2</sup>North Carolina State University.

Two studies were conducted to evaluate the availability of Cu offered to cattle consuming molasses-based supplements. In Exp. 1 (84 d), 24 Braford heifers were randomly assigned to 12 pastures (n = 2 heifers/pasture). Heifers were provided 1.5 kg of TDN and 0.3 kg of supplemental CP/heifer daily using a molasses-cottonseed meal slurry. Three treatments were randomly assigned to pastures (4 pastures/treatment), providing 100 mg of supplemental Cu daily in the form of 1) CuSO<sub>4</sub> (inorganic Cu), or 2) organic-Cu (Availa-Cu; Zinpro Corporation, Eden Prairie, MN). A third treatment received no supplemental Cu. Heifer BW was collected at the start and conclusion of the study. Jugular blood and liver samples were collected on d 0, 29, 56, and 84. In Exp. 2 (72 d), 24 Brahman-crossbred steers were fed the same molasses-cottonseed meal supplement at the same rate used in Exp. 1. Steers were housed in individual pens (15 m<sup>2</sup>) with free-choice access to stargrass hay. Four Cu treatments were assigned to individual steers (6 pens/treatment) providing, 1) 10 ppm Cu from an organic source (Availa-Cu), 2) 10 ppm Cu from Tri-basic Cu chloride (TBCC; Micronutrients Inc., Indianapolis, IN), 3) 30 ppm Cu from TBCC, or 4) 30 ppm Cu, 50:50 ratio of TBCC and organic Cu. Body weights, blood, and liver samples were collected on d 0, 24, 48, and 72. In Exp. 1, liver Cu was similar between heifers supplemented with inorganic and organic Cu. Each source resulted in increased (P < 0.05) liver Cu concentrations compared with the unsupplemented control. Plasma ceruloplasmin concentrations were higher (P < 0.05) for Cu-supplemented heifers, independent of Cu source. Heifer ADG tended (P = 0.11) to increase with Cu supplementation compared with the non-supplemented control. In Exp. 2, liver Cu was greater (P < 0.05) on d 24, 48, and 72 for steers consuming 30 ppm compared with 10 ppm Cu. Steers supplemented with organic Cu had lower DMI compared with steers supplemented with 10 or 30 ppm of TBCC. The inorganic and organic Cu sources evaluated

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. Klopfenstein<sup>1</sup>, <sup>1</sup>University 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\*<sup>1</sup>, J. B. Taylor<sup>2</sup>, J. W. Finley<sup>3</sup>, and J. S. Caton<sup>1</sup>, <sup>1</sup>North Dakota State University, Fargo, ND, <sup>2</sup>USDA-ARS, Dubois, ID, <sup>3</sup>USDA-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<sup>-1</sup> BW·d<sup>-1</sup>, and for CON, 9.5 g·kg<sup>-1</sup> BW·d<sup>-1</sup>. 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