

POSTER PRESENTATIONS  
Animal Behavior and Well-Being: Physiology Emphasis

**T1 Stress affects plasma serotonin, but not tryptophan, in Holstein steer calves.** A. L. Adams,\* T. H. Friend, G. A. Holub, L. R. Berghman, P. K. Riggs, S. M. Garey, C. L. Terrill, and M. J. Carter, *Texas A&M University, College Station.*

Cortisol is a well-known indicator of stress, but little is known about the effects of stress on serotonin and tryptophan in livestock. Previous studies in humans have shown that the brain uses serotonin, derived from tryptophan in the bloodstream, to cope with stress. As serotonin production in the brain increases, plasma tryptophan concentrations are expected to decrease. Furthermore, previous studies in humans have also shown that 90% of serotonin is located in the intestines and released into the bloodstream as an individual experiences stress. The objective of this study was to determine how stress affected plasma serotonin and tryptophan concentrations in calves during handling and transport. Thirty-six 4-mo-old Holstein steer calves were housed in groups of 6 with each group randomly assigned to either transport or control treatments. Transported calves were hauled for 6 h in their groups in a 7.3 m × 2.4 m goose-neck trailer divided into 3 compartments, at an average density of 0.87 m<sup>2</sup>/calf, every 7 d for 5 consecutive wk. Location of groups within the trailer rotated. Simultaneous blood samples were obtained in the trailer or home pen via jugular venipuncture before loading (pre), and after 2, 4, and 6 h of transport. Plasma samples with the highest cortisol concentrations from each treatment (transport: n = 11, control: n = 8) and sampling period (pre: n = 6, 2 h: n = 3, 4 h: n = 6, 6 h: n = 4) were analyzed for concentrations of serotonin and tryptophan. Pearson correlation coefficients were used to determine associations and mixed model ANOVA determined treatment and sampling period effects on serotonin and tryptophan. Serotonin was not correlated with cortisol ( $P = 0.54$ ) or tryptophan ( $P = 0.45$ ), but tryptophan and cortisol were correlated ( $r = -0.52$ ,  $P = 0.02$ ). Treatment did not affect serotonin ( $P = 0.79$ ) or tryptophan ( $P = 0.15$ ). Serotonin was highest ( $148 \pm 16$  ng/mL) after 4 h and lowest ( $46 \pm 21$  ng/mL) after 6 h ( $P = 0.0004$ ), but tryptophan was not affected by sampling period ( $P = 0.64$ ). These results suggest that stress (handling and/or transport) may cause an intestinal response that releases additional serotonin into the bloodstream.

**Key Words:** serotonin, stress, tryptophan

**T2 Development of a novel method for measuring stress in beef cattle.** D. Moya\*<sup>1</sup>, K. S. Schwartzkopf-Genswein<sup>1</sup>, and D. Veira<sup>2</sup>, <sup>1</sup>*Agriculture and Agri-Food Canada, Lethbridge, AB, Canada*, <sup>2</sup>*Agriculture and Agri-Food Canada, Agassiz, BC, Canada*.

A study was conducted to a) determine if bovine hair contains cortisol at measurable levels, and b) identify the effect of hair location and collection method on hair cortisol levels. Hair samples (0.5 g) from the head, neck, shoulder, hip, and switch were collected from 12 Angus crossed bulls ( $313.1 \pm 14.7$  kg BW) using 2 sampling methods: plucking, to ensure collection of the hair follicles; and clipping, using an electric razor to ensure collection of the hair as close as possible to the skin. After a wash with isopropanol, hair samples were ground with a ball mill for 5 min at 22 rps, sonicated with methanol for 30 min, and incubated on a shaker for 18 h, at 50°C and 100 rpm. The supernatant was pipetted off and evaporated in a block heater, at 45°C under a stream of nitrogen. Samples

were reconstituted with phosphate buffered saline before quantification of cortisol with a competitive immunoassay. Data were analyzed with a factorial design, considering hair location and collection method as main factors, using the mixed procedure of SAS. Differences were declared at  $P < 0.05$ . The described method was successful in detecting cortisol in 87.8% of the hair samples, with concentrations ranging from 0.07 to 6.62 pg/mg. A value of zero was used for samples in which no cortisol was detected. The intra-assay coefficient of variation (CV) ranged from 5.91 to 9.96%, while the inter-assay CV ranged from 5.04 to 10.48%. Hair from the switch had the greatest cortisol concentration ( $3.32 \pm 0.20$  pg/mg) compared with all other sampling locations, while hair from the head and the neck ( $2.14$  and  $1.86 \pm 0.20$  pg/mg, respectively) had greater cortisol concentrations than from the shoulder and hip ( $0.83$  and  $0.62 \pm 0.20$  pg/mg, respectively). Cortisol was greater in hair samples collected by clipping than by plucking. Results indicate that hair can be used to measure cortisol levels in beef cattle. Future studies will assess hair cortisol concentration as a biomarker of stress and animal welfare under chronic stress conditions, as well as its relationship with other physiological and behavioral measures of animal welfare.

**Key Words:** hair cortisol, biomarker, welfare

**T3 Body temperature and panting in feedlot cattle.** J. B. Gaughan\*<sup>1</sup> and T. L. Mader<sup>2</sup>, <sup>1</sup>*The University of Queensland, Gatton, Qld, Australia*, <sup>2</sup>*University of Nebraska, Concord.*

Assessment of thermal status during periods of high heat load is essential for the maintenance of cattle wellbeing. Respiration rate (RR) and body temperature (BT) are routinely used as indicators of thermal status. However, they are difficult to obtain under commercial conditions. The panting score (PS) system was designed as a visual assessment of the thermal status of cattle. The PS system uses a 7 point score (0, 1, 2, 2.5, 3, 3.5 and 4) where PS0 indicates no elevation in RR (no thermal stress) and a PS4 indicates severe thermal stress (open mouth, tongue fully extended, head drooped, rapid labored breathing). A PS2 (closed mouth, drooling, elevated RR) indicates that the animal is under moderate heat load. A PS3 (open mouth, tongue extended, drooling, further elevation of RR) is an indicator of high heat load. In this study BT and PS data were obtained from 48 Angus steers over 120 d. Steers were implanted with a BT transmitter on d -31, and BT data were obtained at 30 min intervals. The cattle were housed in 2.43 m × 7.4 m pens (8 steers/pen: 3 transmitter steers/pen), and were fed a finisher diet (NEg = 1.44 Mcal/kg). The PS of the steers was obtained daily ( $\pm 15$  min) at 0600 h (AM), 1200 h (MD) and 1600 h (PM). At the same times, climate variables were obtained from an on-site weather station. Observations were made from outside the pens so as not to influence cattle responses. The 2 closest BT values to the time when PS was obtained were retrospectively downloaded from a logger and averaged. A total of 15,361 observations were used and 2nd order polynomial response curves generated: (AM)  $y = 39.28 - 0.295x + 0.125x^2$  ( $R^2 = 0.99$ ); (MD)  $y = 38.27 + 0.853x - 0.0554x^2$  ( $R^2 = 0.99$ ); (PM)  $y = 38.68 + 0.869x - 0.071x^2$  ( $R^2 = 0.99$ ), where  $y = BT$  (°C) and  $x = PS$ . These data suggest that PS is a good indicator of BT. The BT at MD corresponded to slightly lower PS compared with PM, e.g., for PS1; BT at MD = 39.6°C and

40.1°C at PM. However during AM, BT was lower at PS1, 2 and 2.5 (highest AM value) compared with MD and PM, e.g., for PS2.5; BT at AM = 40.2°C, MD = 40.8°C and PM = 41.1°C. The AM response curve suggests an attempt to increase heat dissipation during the cooler AM period relative to MD and PM.

**Key Words:** panting, body temperature, heat stress

**T4 Use of artificial shade during grazing and its effects on body weight at the end of gestation in red deer (*Cervus elaphus*).** N. G. Mejía, A. Sánchez, A. Paez, and L. Alvarez,\* *Facultad de Medicina Veterinaria y Zootecnia, UNAM, México DF, México.*

In grazing animals, solar radiation and high temperatures can seriously compromise the performance and welfare if they lack the necessary protection. The aim of this study was to determine whether the resource shade affects the body weight and behavior of female red deer during the last 2.5 mo of pregnancy. Two groups (n = 23 each) of pregnant does were grazed in different pens of similar botanical composition and size. In the shaded group, a mesh shade (>80% protection, 60m<sup>2</sup>) was placed. A behavioral scan sampling (10 min) was used to determine the location of animals and their behavior inside the paddock. Ambient and black globe temperature were also measured. All females were weighed at the beginning of the experiment and immediately before delivery. Data was arcsin transformed to be analyzed using a repeated measures ANOVA, correlation and linear regression. Percentage of animals using the shade during daytime was highly correlated with ambient [ $R^2 = 0.7$ ,  $P < 0.05$ ,  $y = (2.45x) + (-6.91)$ ] and black globe temperature [ $R^2 = 0.9$ ,  $P < 0.05$ ,  $y = (2.40x) + (-49.24)$ ]. There were no differences in the percentage of animals grazing during the day ( $P > 0.05$ ). More animals were seen drinking water, and more thermoregulatory behaviors (to get muddy, to introduce forelegs in troughs) were recorded in the unshaded animals ( $11.1 \pm 1$  versus  $6.3 \pm 1$  and  $10 \pm 1.4$  versus  $3.3 \pm 1.4$  respectively,  $P < 0.05$ ). The average daily gain of weight was higher in the shaded group ( $215 \pm 24.1$  versus  $127.1 \pm 23.6$ ,  $g \pm SE$ ,  $P < 0.05$ ). It is concluded that artificial shade during the last 2.5 mo of gestation reduces the thermoregulatory behaviors and improves the average daily gain of weight. PAPIIT IN205810, UNAM.

**Key Words:** animal welfare, body weight, solar radiation

**T5 Evaluation of on-farm methods assessing locomotor disorders of individual or group housed sows.** S. Conte\*<sup>1</sup>, J. Grégoire<sup>1</sup>, R. Bergeron<sup>2</sup>, S. D'Allaire<sup>3</sup>, M.-C. Meunier-Salaün<sup>4</sup>, and N. Devillers<sup>1</sup>, <sup>1</sup>*Agriculture and Agri-Food Canada, Dairy and Swine R & D Centre, Sherbrooke QC, Canada*, <sup>2</sup>*University of Guelph, Alfred Campus, Alfred, ON, Canada*, <sup>3</sup>*Faculty of Veterinary Medicine, University of Montreal, St-Hyacinthe, QC, Canada*, <sup>4</sup>*Institut National de la Recherche Agronomique, UMR1348 Pegase, Saint-Gilles, France.*

The aim was to evaluate methods for on-farm assessment of locomotor disorders in gestating sows, and the influence of housing system on the prevalence of locomotor disorders. Of the 311 sows studied across 10 farms, 120 sows were housed in groups of 4–8 sows per pen and 191 sows were housed in individual stalls. Data recorded were: 3-point gait score, walking speed ( $\leq 0.8$ ,  $\leq 1.25$ ,  $> 1.25$  m/s), stride length ( $< 83$ ,  $< 100$ ,  $\geq 100$  cm), number of steps during 30s at feeding ( $< 3$ ,  $< 6$ ,  $\geq 6$ ), latency to lie down after feeding ( $\leq 30$ ,  $\leq 60$ ,  $> 60$  min), ability to stand up after being stimulated ("stand-up test": moving freely, hesitancy, refusal), number of feet with uneven toe size and bursitis (0, 1,  $> 1$ ), and presence of cracks ( $> 1$  cm) on the side wall. The percentage of sows in each category was calculated. Cochran-Mantel-Haenszel and Chi-squared

tests were used to determine the association between variables and housing systems. Following gait scoring, 49% of sows were sound (score 0), 35.5% walked stiffly (score 1) and 15.5% were visibly lame (score 2). There were no differences between housing systems in the percentage of sows within each gait score ( $P > 0.05$ ). The percentage of sows having feet with uneven toe size, bursitis or cracks on the side wall was higher in stalls than in pens ( $P < 0.05$ ). No associations were found between the 3-point gait score and the number of steps during 30s, the stand-up test score or the latency to lie down after feeding ( $P > 0.05$ ). The percentage of sows having reduced walking speed and stride length was higher for sows scored 2 than for sows scored 0, in stalls only ( $P < 0.05$ ). Results indicated no differences in the prevalence of locomotor disorders between housing systems based on the gait score, but highlighted more foot problems in stalls than in pens. New quantitative indicators such as stride length and walking speed seem to be good indicators of locomotor disorders for sows housed in stalls but not in pens. This suggests that methods used to detect lameness are not always applicable from one housing system to another. Other factors associated with the housing system such as the possibility to exercise may interfere with the assessment.

**Key Words:** gestating sow, locomotor disorders, housing system

**T6 Effectiveness of a non-penetrating captive bolt for the euthanasia of nursing and weaned piglets from 3 to 9 kg.** T. M. Casey-Trott\*<sup>1</sup>, S. G. Nykamp<sup>1</sup>, P. V. Turner<sup>1</sup>, S. T. Millman<sup>2</sup>, and T. M. Widowski<sup>1</sup>, <sup>1</sup>*University of Guelph, Guelph, Ontario, Canada*, <sup>2</sup>*Iowa State University, Ames.*

A non-penetrating captive bolt (NPCB) has been shown to be highly effective for euthanasia in neonatal piglets. The objective of this study was to determine the effectiveness of the NPCB for euthanasia of nursing and weaned piglets from 3 to 9kg (5–49 d of age). The NPCB was used by 15 stock people from 6 farms to euthanize 150 compromised piglets (3 kg: 55 piglets, 5 kg: 45 piglets, 7 kg: 25 piglets, 9 kg: 25 piglets). The NPCB was placed on the frontal bone and fired twice in rapid succession. Piglets were monitored for signs of sensibility using brainstem and spinal reflexes. Duration of neuromuscular leg spasms and time to cardiac arrest were also recorded. CT scans and macroscopic scoring were completed post mortem to quantify the degree of skull fracture and brain hemorrhage. Data were analyzed in SAS 9.2 using proc mixed with an age, weight interaction. The NPCB caused immediate and sustained insensibility until death in 98.6% of piglets. Leg spasms ceased in  $< 5$  min in 97.3% of the piglets and cardiac arrest was achieved by 98% in  $< 10$  min. Stock person variation was significant for duration of leg spasms ( $P = 0.0443$ ), but not time to cardiac arrest ( $P = 0.2022$ ). There were no significant differences among weight groups for either the duration of leg spasms ( $P = 0.7338$ ) or time to cardiac arrest ( $P = 0.6585$ ). However, age significantly affected the duration of leg spasms ( $P = 0.0417$ ) with younger piglets ( $\leq 21$  d) having a shorter duration than older piglets ( $\geq 22$  d). Average fracture displacement was 8.3 mm ( $\pm 1.0SE$ ). Two piglets from the 9kg category had fractures present but no displacement. Moderate to severe subdural-dorsal (SDD) hemorrhage was reported in at least 85% of piglets in each weight category. Moderate to severe subdural-ventral (SDV) hemorrhage was reported in at least 60% of piglets from weight categories 3, 5, and 7kg; whereas the SDV hemorrhage for the 9kg category was predominantly minimal to mild (56%). The NPCB was highly effective for the euthanasia of piglets up to 9kg (49 d) based on immediate insensibility until death. However, age affects should be further studied to ensure the technique remains effective if it is used on piglets beyond this range.

**Key Words:** euthanasia, piglet, captive bolt

**T7 Trailer compartment and trip duration affect stress of pigs transported under Canadian conditions.** Y. M. Seddon<sup>\*1</sup>, J. Brown<sup>1</sup>, T. Crowe<sup>2</sup>, R. Bergeron<sup>3</sup>, T. Widowski<sup>3</sup>, L. Faucitano<sup>4</sup>, and H. Gonyou<sup>1,2</sup>, <sup>1</sup>Prairie Swine Centre, Saskatoon, SK, Canada, <sup>2</sup>University of Saskatchewan, Saskatoon, SK, Canada, <sup>3</sup>University of Guelph, Guelph, ON, Canada, <sup>4</sup>Dairy and Swine Research and Development Centre, Sherbrooke, QC, Canada.

Long transport times and trailer designs in use in western Canada have raised concerns regarding the welfare of pigs transported to market. Objectives of this study were to assess the effects of the internal trailer compartments (C) and trip duration on measures of stress in pigs transported in western Canada. Over 4 weeks in winter (W) and 4 weeks in summer (S), pigs from one farm (121 ± 0.35 kg) were monitored during transport to market. Each week, market pigs were weighed, identified and loaded onto 3 pot-belly trailers at a density of 0.38 m<sup>2</sup>/pig. Trailers were loaded at 6-h (h) intervals to complete journey times of 6, 12 and 18 h, arriving at the abattoir at the same time. The study focused on pigs located in 4 C, namely C1 and C4 (front and rear of the upper deck), C5 (front of the middle deck) and C10 (rear of the bottom deck). At the abattoir, pigs were rested for 1.5 h before slaughter. Blood was collected from 4 pigs per C at exsanguination (total n = 384), and analyzed for packed cell volume (PCV), creatine phosphokinase (CPK), cortisol and lactate. Statistical analysis using the PROC mixed procedure in SAS determined the effects of season, week, travel duration and C on the stress measures. CPK levels were affected by trip duration (6 h: 4172, 12 h: 6552, 18 h: 9697 ± 1659 IU/L; *P* < 0.05) and C (C1: 3834, C4: 8676, C5: 5754, C10: 8968 ± 1455 IU/L; *P* < 0.0001). Despite longer trip durations, CPK levels did not alter in C1, but rose in C4, C5, and C10 (12 h), with C4 and C10 showing the highest levels following 18 h transport (*P* < 0.05). Cortisol was higher (*P* < 0.05) in S than W. C and season affected lactate, with lactate levels being significantly higher (*P* < 0.05) in pigs transported in C1 and C4 than in the other C in W. Data suggest longer trip durations caused increased stress, and seasons present challenging conditions, yet the compartment location can either mitigate or aggravate the stress response. Therefore, determining conditions within the C, such as temperature and humidity extremes, vibrations and G-forces would help to understand these negative effects and assist in the development of targeted improvements to trailer design.

**Key Words:** transport, stress, pig

**T8 Effect of commercial transport by road on prevalence of bruises and meat pH of beef cattle in Brazil.** M. H. Romero<sup>\*1</sup>, M. J. R. Paranhos da Costa<sup>2</sup>, L. F. Uribe<sup>1</sup>, J. Braga<sup>2</sup>, and A. Riobueno<sup>2</sup>, <sup>1</sup>Universidad de Caldas, Manizales, Caldas, Colombia, <sup>2</sup>La Universidad Estadual Paulista, Jaboticabal, Sao Paulo, Brazil.

Cattle are exposed to various handling and transport conditions during marketing and previous to slaughter. Brazil is the principal meat producer in South America. Commercial crossbreeds of Zebu cattle (n = 1841) were evaluated to determine prevalence and risk factors for carcasses with bruises in a slaughterhouse that had modern facilities and had implemented animal welfare practices and driver training. Measurement of pH was performed in the *Longissimus thoracis* muscle at the level of the 5th and 6th rib, approximately 24 h after slaughter in refrigerated carcasses. A logistic regression analysis was done. Bruise prevalence was 59%. A total of 2041 bruises were found (mean 1.1 bruises/carcass). Bruises in subcutaneous tissue (939, 76%) were more frequent than bruises in muscle tissue (24%). The mean time transport was 4.51 ± 1.21 h, and distance ranged between 65 Km and 334 Km. The fat cover was associated with the presence of bruises. Thin animals bruised more easily than fat animals due to a lack of fat cover (*P* ≤ 0.01). Average

incidences of meat pH greater than 5.8 and 6.0 were 24.6% and 0.3% respectively. Time of transport and distance were related with high pH (*P* ≤ 0.01). Prevalence of bruises was not significantly associated (*P* ≥ 0.01) with increased carcass pH values, transport time and type of truck. The results suggest that transport time and distance can affect meat quality.

**Key Words:** bruises, slaughter, well-being

**T9 The effect of water sprinkling on behavior and core body temperature of market hogs transported during summer.** J. Fox<sup>\*1</sup>, T. Widowski<sup>1</sup>, S. Torrey<sup>2</sup>, E. Nannoni<sup>4</sup>, R. Bergeron<sup>5</sup>, HW Gonyou<sup>6</sup>, JA Brown<sup>6</sup>, T. Crowe<sup>7</sup>, and L. Faucitano<sup>3</sup>, <sup>1</sup>University of Guelph, Guelph, ON, Canada, <sup>2</sup>Agriculture and Agri-Food Canada, Guelph, ON, Canada, <sup>3</sup>Agriculture and Agri-Food Canada, Sherbrooke, QC, Canada, <sup>4</sup>University of Bologna, Bologna, Italy, <sup>5</sup>University of Guelph, Alfred, ON, Canada, <sup>6</sup>Prairie Swine Centre, Saskatoon, SK, Canada, <sup>7</sup>University of Saskatchewan, Saskatoon, SK, Canada.

Hogs are often transported to slaughter under conditions exceeding their thermo-neutral zones, which can lead to reduced welfare and increased in-transit loss. Water sprinkling during lairage decreases micro-climate and hog body temperatures and improves welfare, but there is no clear evidence of these effects during transport. The aim of this study was to observe if sprinkling hogs in stationary trailers before and after transport decreased signs of heat stress. In each of 12 weeks from May to September 2011, 2 pot-belly trailers with 208 hogs per trailer were transported 2h to slaughter. One was outfitted with a custom made sprinkler system that ran for 5min (~125 L) immediately before departure from the farm and immediately before unloading at the plant. In each trailer, 4 test compartments (1 on the top deck, 2 on the middle deck, and 1 on the bottom deck) were outfitted with cameras, and the core body temperature (CBT) of 4 randomly chosen hogs (n = 384) in each were recorded using orally administered iButtons. Trailer and deck loading order were randomized. Behaviors during transport, unloading and during lairage were recorded from video or live observations. Data were analyzed through ANOVA with ambient temperature external to the truck (AmbT) as a co-variant. AmbT averaged 19.5°C ± 3.8°C (range: 14–26°C). At AmbT > 23°C, there was no effect of sprinkling on behavior on-truck (standing, sitting or lying), but at AmbT < 23°C, more hogs stood on sprinkled trucks (*P* < 0.05). Sprinkling did not affect slips or falls during unloading. In lairage, latency to lie was shorter when AmbT exceeded 23°C (*P* < 0.05) and sprinkled hogs spent more time lying and less time sitting (*P* < 0.05) and had fewer drinking bouts than controls (*P* < 0.0001) regardless of AmbT. CBT increased between loading and departure and decreased while in transit for all hogs (*P* < 0.0001) and sprinkling further reduced CBT at arrival at AmbT > 23°C (*P* < 0.05). Therefore, sprinkling hogs when ambient temperature exceeds 23°C can help to alleviate transport-related heat stress without detrimental effects on unloading.

**Key Words:** pigs, transport, heat stress

**T10 Characteristics of bruises in carcasses of commercial zebu cattle in Colombia.** M. H. Romero, \* L. F. Uribe, J. A. Sánchez, and H. Mesa, Universidad de Caldas, Manizales, Caldas, Colombia.

Bruises detected on carcasses at the abattoir, may provide information about the traumatic situations the animal endure during the pre-slaughter period. The objective of this study was to describe the gross characteristics of bruises in commercial zebu cattle of different methods of selling and management. The number of bruises and their distribution on the carcass, as well as their severity, shape and size were assessed

post mortem in a slaughterhouse in Colombia. A descriptive statistical analysis was done. A total of 1195 bruises were found on 453 (38.3%) of the carcasses evaluated (n = 1177). Females (n = 453) had 649 bruises (mean 3.2 bruises/carcass) whereas males (n = 250) had 530 bruises (mean 2.1 bruises/carcass). Cattle transported from livestock market had 3 times more bruises than cattle transported directly from the farm (35% and 59%, respectively). The pin (*tuber isquiadicum*), the hip (*tuber coxae*) and the loin were the more frequently observed bruises (32.9, 25 and 21.3%, respectively). Bruises with muscle tissue affected (grade 2) were more prevalent (80%); however, the bruises were small ( $\geq 2$  and  $\leq 8$  cm). Circular shaped bruises were most frequent (71%, n = 850), followed by irregular, linear, speckled and tramline shaped

bruises (21, 3.6, 3.4 and 1.0%, respectively). speckled shaped bruises were located predominantly in the loin, and can be caused by electric prod or pointed sticks. The model of logistic regression showed that sex and time of transport were associated with the presence of bruising ( $P \leq 0.01$ ). Lairage time was not considered a risk factor for the presence and severity of bruises ( $P \geq 0.1$ ). The presence of bruises located more frequently in the pin and the hip suggest that bruises are inflicted by rude handling and inadequate design of the trucks and facilities. Cattle transport infrastructure must be improved in the area being studied, as must driver training; animal welfare practice must be promoted in all links of the meat chain and research developed in this particular area.

**Key Words:** bruises, cattle, welfare