Evaluation of biomechanical strength and strain of bovine hoof lamina in elevated mobility score market weight cattle

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Objective

Impaired mobility of cattle arriving at packing plants gained considerable attention in the fall of 2013. In addition to a stiff gait and reluctance to move, cattle presented with increased respiratory rates and muscle tremors. In the most severe cases, animals were observed to slough one or more hooves (claw horn capsules) during transport or while in lairage. Affected animals experienced significant discomfort and when hoof sloughing occurred at the packing plant, these animals were unable to be processed creating both an animal welfare issue as well an economic loss to the packer. It is believed that a better understanding of possible molecular causes of this condition would help feeders develop better feeding and management practices to prevent the disease. This report describes experimental evaluation of the relationship between the mobility of market weight cattle and the biomechanical properties of the laminar corium.

Materials and methods

Eighty-six market weight cattle were evaluated at a commercial slaughter facility. Mobility scores, as described by the North American Meat Institute, were assigned by trained company employees. Animals were observed and scored during antemortem exam and subsequently marked using a color code for each score. All animals with indications of disease or blindness were excluded. Following slaughter, both front hooves were collected within the packing plant and frozen for transportation to the research facility. Using a randomization chart, left or right hooves were selected and biomechanically tested using a test frame to determine the force required to remove the hoof horn from the pedal bone. The test results were compared based on ante-mortem locomotion score.

Results

In biomechanical testing all specimens failed at the junction of the dermal and epidermal lamina. This indicates that the corium and basement membrane were in a healthy state at the time the animal was harvested. The strain at break was significantly different based on the mobility scores (p value = 0.0001), with higher mobility scores demonstrating more elasticity of the lamina (strain) before breaking. Peak load at break demonstrated a downward trend as mobility score increased, but did not reach the level of statistical significance. Taken together these results demonstrate that as the mobility score increases the lamina becomes more prone to stretching with minimal resistance and ultimately capable of breaking.

Conclusions

An increased strain at break is consistent with the clinical presentation of the lamina of higher mobility score animals stretching and allowing the pedal bone to sink. The results of this study suggest that when other causes of disease or blindness are excluded there is a direct correlation of mobility score with physiologic weakening of the lamina and the potential for sinking or sloughing of the hard hoof horn. This finding is consistent with clinical reports of high mobility animals losing their hooves. Studies to date have focused on muscle-related pathology as a possible underlying issue of the observed clinical signs. The study reported here not only explains a potential cause of the hoof sloughing (the most serious of observed signs) but also the cause of impaired mobility as possibly associated with degeneration and necrosis of the dermal-epidermal junction.