CHARACTERIZATION OF KNOWN AGE BRUISES IN BEEF CATTLE THROUGH INNOVATIVE FORENSIC TECHNIQUES

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I. INTRODUCTION

Bruises are a very good indicator of compromised animal welfare and represent the principal economical loss for the Uruguayan meat industry, according to the three national quality audits. The last audit showed that 71% of the carcasses had at least one bruise and 24% had at least one bruise implying muscle removal [1], representing 37% of the annually meat chain losses [2]. Both from the ethical and economic point of view, Uruguay must identify the causes and stages where bruising occurs. Knowing bruises age and therefore the moment where they have probably been inflicted, would make it possible to build corrective measures, educate and train the people directly involved. The aim of this study was to characterize bruises of diverse known ages, through different innovative techniques.

II. MATERIALS AND METHODS

60 Hereford steers, 30 months old and 530 kg of liveweight were involved in this experiment. One bruise per steer was inflicted at different preslaughter times (Treatments) by an *ad hoc* mechanical device, affecting muscle at the rump region, after applying local anesthesia. Treatments (T) were: T1: 1 hour, T2: 5, T3: 9, T4: 13, T5: 17 and T6: 23 hours preslaughter. After slaughter, diverse pathological reactions were registered at the abattoir and one sample per bruise was extracted for histological analysis.

Determinations at the abattoir. Bruises colour using Gracey's visual scale, from red bright to orange, associated to time; Objective colour at the L*, a*, b* space (Konica Minolta colorimeter, CR-400); Elasticity at heathy and injured tissue by elastosonography; Temperature at healthy and injured tissue through infrared thermography (IRT; PALMER WHAL camera, HSI 3000).

Determinations at the Laboratory. Subsamples of injured tissue were extracted and preserved in formaldehyde. After 24 hours, microscopic analyses were performed: Hemorrhage: presence or absence; Inflammatory infiltrate: grade scale from 0 (absence) to 3 (severe) and location (adipose-connective, muscle, or both tissues); Edema: presence or absence; Necrosis: grade scale from 0 (absence) to 3 (major); Fibrosis: presence or absence. Analysis of variance were carried out for objective colour data and infrared thermography data, frequency analysis for subjective colour and histology (The SAS System, 9.3) and non parametric tests for elastosonography.

III. RESULTS AND DISCUSSION

Neither subjective (Gracey's visual scale) nor objective colour (L*, a*, b*) differed between T. Elasticity of muscle fibers differ between healthy and affected tissue ($P<0.05$), but not between T.

Infrared thermography showed that the temperature on injured tissue (bruise) was always lower than the healthy tissue temperature (Table 1). This is because of blood vessels rupture in the injured tissue, caused a greater energy exchange with the environment with its consequent cooling [3]. Infrared thermography also showed that differences in temperature between healthy and affected tissues from the same muscle, were greater in older bruises (Table 1, $P<0.05$).

Table 1. Temperature of injured and healthy tissue and its difference (IRT), by grouped treatments

Group of treatments	Temperature of healthy tissue THT	Temperature of injured tissue TIT	THT - TIT
≤ 5 hours (T1 and T2)	29.90	27.73	2.17
9 and 13 hours (T3 and T4)	31.66	29.29	2.37
≥ 17 hours (T5 and T6)	31.17	28.14	3.03

The presence of inflammatory infiltrate, its severity and location, as well as the presence of edema, did not differ between T. Edema increased vascular permeability and is one of the classic inflammation indicators. In 100% of the subsamples (n = 52) with hemorrhage and inflammatory infiltrate, the presence of edema was verified. However, it was not related to bruises age. Fibrosis was not observed in this experiment. Time was probably not enough for its appearance even in T6. Necrosis, defined as irreversible cell damage, was reported in 56% of bruises and 82% of them were Grade 1. The grade of necrosis was associated to bruise age ($P<0,05$), registering grade 2 only in bruises with more than 13 hours (T5 and T6) and grade 3 only in bruises with more than 17 hours (T6). Since the average lairage time at the slaughterhouse is 12 hours in Uruguay, necrosis grade 1 could be associated to bruises inflicted at the farm or during transport and grades 2 and 3, to bruises inflicted at the abattoir.

IV. CONCLUSION

Infrared thermography and necrosis would be useful to determine bruises age. The practicality of using the Infrared camera in the slaughter line, makes it a promising tool for the meat industry. Further research is being conducted in that sense.

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