

LAIRAGE TIME AND TEMPERAMENT EFFECTS ON GLYCOGEN CONTENT IN HEREFORD STEERS

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Abstract -The aim of this study was to evaluate the effects of pre slaughter lairage time and temperament on glycogen content. Fourteen Hereford steers fed on pasture were assigned to two treatments (T) according to lairage time: 3 hours (T1, n = 7) and 12 hours (T2, n = 7). Individual temperament was assessed using crush score and flight speed. Muscle samples were extracted from *Longissimus thoracis et lumborum* (LM) muscles 45 minutes *post mortem*, to determine glycogen content. To evaluate the effect of lairage time and temperament on glycogen content, analysis of variance was used fitting a general linear model including the fixed effects of lairage time, CS, and FS in classes. Adjusted means were compared by the Tukey test and the results were considered statistically significant when $P < 0.05$. Muscle glycogen was lower ($P < 0.05$) in T1 suggesting a higher level of stress in this treatment. Furthermore, more excitable animals had lower glycogen content ($P < 0.05$). Considering that glycogen can affect other meat quality traits, it is important to be alert to situations where the glycogen content is reduced.

Key Words - crush score, flight speed, pre-slaughter procedures

I. INTRODUCTION

Pre-slaughter procedures are considered critical for cattle because the animals are exposed to stressful situations as fear, hunger, increased physical activity that may negatively affect meat quality [1]. Gallo et al. [2] showed that long pre slaughter lairage leads to a negative impact on meat quality. However, del Campo et al. [3] and Mounier et al. [4] reported that longer lairage time had a positive effect on the

meat acidification process because allowed cattle to recover from the stress of transport. The impact of lairage time on meat quality is mediated by stress physiology, and there is evidence that cattle with more excitable temperaments are more susceptible to stressful situations [5, 6]. There are studies showing that more excitable cattle have higher ultimate pH values, higher incidence of dark cuts, and higher values of shear force [3, 7, 8]. However, most of the cited studies have explored the isolated effect of either lairage time or temperament on meat quality and do not consider muscle glycogen content as an alert indicator for meat quality problems. Therefore, the aim of this study was to evaluate the effects of lairage time and temperament on glycogen of Hereford steers.

II. MATERIALS AND METHODS

The experiment was developed by the National Institute of Agricultural Research – INIA, Tacuarembó Research Station, Uruguay. Fourteen Hereford steers, three years old, were kept on grazing system with continuous stocking in a single group at the Experimental Station of Glencoe (INIA). Temperament assessment was carried out simultaneously with the handling for weighing, being evaluated by one trained observer, one week before the steers went to the slaughterhouse. Two temperament measurements were used: a) crush score (CS, adapted by Grandin [9]) by applying a visual score from 1 to 4 (calm to excitable, respectively); and b) flight speed (FS), defined by the speed (m/s) taken by each animal to cover a known distance (in this

case, 2 m) just after being released from the squeeze chute, as per Burrow et al. [10]. Faster animals were considered to have a more excitable temperament [11]. The animals were randomly assigned into two treatments, according to lairage time in the slaughterhouse: 3 hours (T1, n = 7) and 12 hours (T2, n = 7). Animals were slaughtered with 500 kg of live weight, on the same day, in a commercial abattoir licensed to export meat and following animal welfare standard procedures. The animals were fastened during the transport and lairage period and had access to water *ad libitum* in the lairage pen. Samples of approximately 20 grams of the *Longissimus thoracis et lumborum* muscles (LTL) were extracted at 45 minutes *post mortem* to determine glycogen content. The samples were wrapped in aluminum foil and frozen at -80°C in nitrogen tank immediately after extraction. Glycogen content was determined on 2 g of muscle, heated to 100 °C in a test tube with 8 ml of 2 M HCl for two hours, then filtered and neutralized with 2 N NaOH [12]. Measurements were taken using the glucose oxidase procedure, where the residues were measured [13]. The results were expressed as milligrams of glucose residue per gram of muscle (mg/g). To evaluate the effect of lairage time and temperament on glycogen, analysis of variance was used fitting a general linear model including the fixed effects of lairage time, CS, and FS in classes. Adjusted means were compared by the Tukey test and the results were considered statistically significant when $P < 0.05$. For these analyses, the flight speed variable was categorized into three classes based on terciles, as follows: low, medium, and high FS.

III. RESULTS AND DISCUSSION

The muscle glycogen content differed between treatments ($F_{1, 13} = 12.93$; $P = 0.007$). Animals kept in lairage for 3 hours showed lower muscle glycogen content than those kept for 12 hours (3.03 ± 0.85 and 8.39 ± 1.11 , respectively). Brown et al. [14] reported that muscle glycogen concentration of 8 to 9 mg/g can cause elevation of pH. In this study, animals from both treatments had glycogen

concentrations below those proposed by the mentioned author. However, the concentration was sufficient for promoting proper acidification of the muscle [15]. Muir et al. [16] consider that pasture-raised animals are more susceptible to pre-slaughter stress, because they may have less muscle glycogen stores and therefore higher risk of increased meat pH when compared to grain-fed steers. The animals evaluated in this experiment were raised on pasture, which may have contributed to the low muscle glycogen content registered for both treatments and especially for T1. Moreover, the low muscle glycogen concentration registered in T1 may be associated with stress during the pre-slaughter handling [1]. Cafe et al. [5] explained that in excitable animals the stress responses related to the activation of hypothalamic-pituitary-adrenal axis (HPA) and also the sympatho-adrenal-medullary responses can be more intense. Thus, in more 'excitable/reactive' individuals the depletion of muscular glycogen concentration would be more intense than in calmer ones, increasing the risk of meat quality defects [17,18,19]. In the present experiment the more reactive animals (crush score 4) showed lower concentration ($P < 0.05$) of glycogen in the muscle when compared to calmer individuals (crush score 2, Table 1).

Table 1. Effect of temperament traits (CS and FS) of Hereford steers on muscle glycogen content

Traits	N	Glycogen (mg/g)
CS		
1	0	-
2	8	8.72 ^a ±1.34
3	4	7.02 ^{ab} ±1.91
4	2	1.38 ^b ±0.42
FS		
1	5	6.97±2.27
2	5	5.37±1.50
3	4	4.78±1.66

Data show average ± standard error. Crush score and flight speed are the temperament variables analyzed. Means followed by the same letter in columns do not differ by Tukey test at 5% probability.

However, flight speed did not have a significant effect on glycogen concentrations, consistent with other studies [20, 21]. This difference in the effects of both temperament traits on muscle

glycogen concentration could be explained by the fact that flight speed and crush scores are independent traits, measuring different aspects of the animal personality [22, 23].

IV. CONCLUSION

In conclusion, animals kept in lairage for 3 hours had lower muscle glycogen storage than those kept for 12 hours and animals with a more excitable temperament had lower muscle glycogen content than calmer ones. Thus, the shorter pre-slaughter lairage suggested a higher risk regarding meat quality, probably due to the higher level of stress in these animals. In addition, even for Hereford cattle, recognized as the calmest among the British breeds, individual temperament should be considered, as it could affect meat quality.

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