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Evaluation of Changes in Management Practices on Frequency of DFD Meat in Cattle

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Abstract: Five modifications in ante mortem management practices were evaluated in their association with the presence of DFD meat. The study was done in winter in 2 feedlots in Mexicali, Baja California, using information from 400 animals organized in 2×2 tables. The results show 30.27% of DFD meat. Moreover, temperatures above 16°C during driving, the use of the whip instead of the plastic goad and longer waiting time in rest pens continued to be factors related themselves ($p<0.05$) with the presence of DFD meat. Non-mixing animals among pens for their transportation as well as the total waiting time prior to slaughter resulted non-associated ($p>0.05$). The high percentage of DFD meat during winter, even with changes in management practices, makes it necessary to continue evaluating practices of animal wellbeing in searching of decreasing the amount of DFD meat.

Key words: DFD meat, stress, management practices, meat quality

INTRODUCTION

The presence of DFD (dark, firm and dry) meat is a problem of quality in the beef industry. When the meat has a pH≥5.8 at 24 h postmortem and a high water retention capability value, it becomes dark (Warris, 2003). Thus, its commercialization is difficult since consumers associate its dark color with old animals or bad storage conditions. DFD meat originates from animal stress prior to or during slaughter (Warris, 2003). This stress can come from several sources such as: Management, movements, novelties, hunger, fatigue, thirst, lesions, extreme temperatures, deficiencies in the design of insensibilization equipment and lack of maintenance of equipment and installations (Grandin, 1996; Gallo, 2003). In a previous research, Perez *et al.* (2006) researched 26 factors probably related with the presence of DFD meat. Of these, 5 proved highly association with OR values between 10 and 35.

The aim of this research was to evaluate the changes in ante mortem management practices and their association with the presence of DFD meat.

MATERIALS AND METHODS

The study was realized in 2 local feedlots and in the installations of a Federal Inspection Type Slaughter plant in the city of Mexicali, B.C., Mexico during winter. The region is geographically placed at 32° 40' N Latitude, 115° 28' W Longitude, at an altitude of 10 m above sea level, in Northwestern Mexico. The winter period was from December to February. In order to obtain information, questionnaires per fattening, transport and slaughterhouse areas were applied. The description of the questionnaires, description of the study area, management practices prior to slaughter and management factors related ($p<0.05$) with DFD meat are all in Perez *et al.* (2006). The changes imposed to associated management factors are shown in Table 1.

Variables under study: The occurrence of DFD meat was estimated using 400 carcasses taken at random during the study period. At 24 h after slaughtering the animals, the pH values and color variables (L* and C*) were taken from the carcass, specifically from the *Longissimus dorsi* muscle between the 11th and 12th ribs. The pH was determined using a Delta TRAK ISFET pH 101 (Delta TRAK, Inc., Pleasanton, CA., U.S.A.) measuring in the center of the muscle. For color variables (L* and C*), measured on the surface of the muscle, a Specular Component Included (SCI), a D_{65} illuminant and a 10° observatory were used. A time of 30 min between cut and measurement was considered. L* determines luminosity ($0 \leq L^* \leq 100$) and C* determines chroma, calculated as

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Table 1: Ante mortem management changes to be evaluated

Management practice	Imposed change
Temperature during driving	Morning shipping (5 am to 8 am) *vs* afternoon shipping (12 pm a 3 pm)
Spurring instrument	Whip for plastic goad
Animals mixed from several pens during transportation	Transport from a single pen
Waiting time in the resting pens in the slaughterhouse	Less than 4 h *vs* 19 h
Total waiting time from arrival to slaughter	Slaughter on the same day of shipping

Table 2: Meat classification according to pH, L* and C* values

Meat type	pH	L*	C*
Normal	5.4-5.8	40-60	> 30
Dark	< 5.8	< 40	< 30
DFD	≤5.8	< 40	< 30

Wulf *et al.* (2002), Forrest *et al.* (1979) and Minolta (1994)

Table 3: Association values with confidence intervals of 95% for modified management factors and occurrence of DFD meat in winter

Management factor	OR	CI	95%
Temperature during driving			
Above 16°C			
*Below 16°C	6.62	3.20	13.68
Spurring instrument			
Whip			
*Electric goad	4.90	2.53	9.49
Animals from a single pen during transportation			
Animals mixed from several pens			
*Animals from a single pen	NS	-	-
Waiting time in the resting pens			
> 1h 40 min			
*< 1h 40 min	20.43	8.90	50.90
Total waiting time to slaughter			
> 13 h			
*< 13 h	NS	-	-

$(a^{*2}+ b^{*2})^{0.5}$ (Young *et al.*, 2003). All measurements were done by triplicate. The meat was classified as normal, dark and DFD according to the criteria established by Wulf *et al.* (2002), Forrest *et al.* (1979) and Minolta (1994) (Table 2). The association of the imposed modifications on the management factor with the occurrence of DFD meat was evaluated by OR using the LOGISTIC procedure of the SAS software (SAS Inst. Inc., Cary, NC).

RESULTS

The occurrence of DFD meat in winter was of 30.27%. The association values of the imposed modifications on the management factor in ante mortem practices with the presence of DFD meat are shown in Table 3. An environmental temperature above 16°C during the driving, a change in the spurring instrument (whip instead of goad) and a time in the resting pens over 1 h 40 min showed association ($p<0.05$) with presence of DFD meat. Non-mixing animals among pens for transporting to the slaughterhouse and total waiting time prior to slaughter did not show association ($p>0.05$).

DISCUSSION

The value of 30.37% for the frequency of DFD meat in the study was 3.72 greater than that reported by Perez *et al.* (2006) for the same feedlots. During October to February Kreikemeier *et al.* (1998) found percentage values of DFD meat between 0.43 and 0.69 and for the months of July and August, they were between 0.9 and 1.4. Higher values are reported for the summer season, around 5%, by Janloo *et al.* (1998) and 14% by Gallo *et al.* (2003), with a clear decrease in autumn (Tarrant and Grandin, 1980). In this study the high value for occurrence of DFD meat suggest the presence of interactions between environmental and physiologic factors on the animal's well-being, therefore a greater attention in management during slaughter is required. Furthermore, the lack of training and continuous rotation of the personnel in the slaughterhouse as well as general maintenance of the equipment in the slaughterhouse installations, as components of this interaction, can act on the visible result of DFD meat. Regarding this, Gallo *et al.* (2003) mention that having the adequate insensibilization equipment and proper training of the personnel in charge of stunning and bleeding the animals increases the efficiency of the cattle insensibilization process and therefore reduces the frequency of DFD meat. Efficient, expert and calm handling of the cattle using the recommended techniques and installations, preventing pain and accidental lesions will decrease animal stress and avoid deficiencies in meat quality (Grandin, 2001).

Changing the time of driving the animals for their transportation to the slaughterhouse from noon to the morning continued to be significant ($p<0.05$) in the presence of DFD meat. Although its odd ratio decreased from 9.51 in Perez *et al.* (2006) to 6.62, the presence of drastic changes in environmental temperatures during this season, from 0°C at night to fluctuations between 17 and 25°C at noon, continues to be a stress factor for the animal's well-being.

Changing the goad for a whip as spurring instrument was not a cause of non association ($p<0.05$) in the presence of DFD meat. Not being used to this instrument, caused stress in the animals, probably due to its novelty. According to this, Grandin (2001) mentioned that not being used to handling with new instruments, is a stress provoker in the animals.

Of the changes done in this study, not-mixing animals from several pens for their transportation was not significant ($p>0.5$) in the presence of DFD meat since the familiarity among the animals helped to avoid dominant hierarchy fights, shoving and head butting (Kreikemeier *et al.*, 1998; Warris, 2003).

Even when the waiting time in the resting pens prior to slaughter was reduced to less than 4 h, the values of association with the frequency of DFD meat were high in magnitude (OR = 20.43). During this study, upon arriving at the slaughterhouse the animals were confined in a pen where they were mixed with animals from other pens from the same feedlot. Animal stress was probably caused by the psychological stress due to fights among them, struggle for hierarchy, high animal density in the pens, new environment in the slaughterhouse and the presence of noise, as mentioned by Wulf *et al.* (1997). Physical stress by hunger, fatigue, lesions, besides the physiological stress, can deplete the reserves of muscle glycogen and propitiate the presence of DFD meat (Kreikemeier *et al.*, 1998; Immoen *et al.*, 2000). However, it was observed that decreasing the total waiting time of the animals from arriving to the slaughterhouse to the slaughter itself was not associated ($p>0.05$) with the presence of DFD meat since the animals are slaughtered on the same day of arrival, contrary to what is described in the study by Perez *et al.* (2006) where the animals are slaughtered on the following day. Mention that when animals are kept for more than one day in the pens, the reserves of glycogen decrease because of factors which propitiate stress, such as long periods without food which in turn results in DFD meat.

CONCLUSION

Changes in the time of driving, the use of the whip and waiting time in the rest pens prior to slaughter were associated with the presence of DFD meat. Even with the modifications imposed on management prior to slaughter, there was a high occurrence of DFD meat (30.27%). Then, it becomes necessary to continue evaluating practices of animal well-being in searching of decreasing this problem of the beef industry.

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