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Relationship Between Management Factors and the Occurrence of DFD Meat in Cattle

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Abstract: A total of 26 management factors that affect the occurrence of DFD meat, were evaluated. Data was obtained in a local feedlot and at a Federal Inspection Type slaughter plant during the months of December to March. Three different weekly questionnaires were taken to get information about managing practices before slaughtering at five random visits to the feedlot. Managing practices were grouped according to feeding pens, transport, situation before slaughtering and staying at the slaughter plant. Two hundred and thirty-three carcasses between 18 and 24 h post mortem were chosen at random and pH, color (L*, a* and C*) were recorded for the classification of meat as normal, dark, or DFD. Dark meat was not detected. The relationship between managing factor and the occurrence of DFD meat was evaluated based on Odds Ratio (OR), estimated by 2x2 contingency tables. The percentage of DFD meat was 8.15%; the variables favoring the occurrence of DFD meat were: Cattle herding time to get on the transportation facilities of more than 35 min (OR= 10.53), environmental temperature above 16°C; using a plastic stick for cattle driving (OR=20.25), joining animals of different stockyards on the transport (OR= 34.23) and keeping the cattle for more than 19 h in the rest pen (OR= 11.13). Changes in ante mortem managing practices are suggested in order to minimize the occurrence of DFD meat.

Key words: DFD meat, stress, meat quality

INTRODUCTION

Actually, DFD meat (dark, firm and dry) is of great importance, as its presence on the market causes commercialization difficulties, because of its old-meat appearance. United Kingdom report 10% of DFD meat occurrence, in contrast to 4% in the United States[1]. In the municipality of Mexicali, Baja California, Mexico, several enterprises are located, that are dedicated to feedlot intensive livestock feeding, with an annual fattening inventory of more than 370,000 head of cattle. Besides having three slaughter plants of Federal Inspection Type (FIT) with a system of permanent classification, the previous makes it important to study the occurrence of abovementioned condition and the factors which produce it. DFD meat originates from the stress to which the animal is subject before and during slaughter. When the animal is exposed to stress for many hours, glycogen reserves in the muscle are used up, so that in the moment of sacrifice and initiating anaerobic glycolysis the amount of glycogen is scarce, which provokes a minimum drop of pH at 24 h after slaughter, causing the record of values to be higher than 5.8[2]. In this type of meat, besides presenting high pH, little or zero exudation is produced, it absorbs more light and, consequently, its appearance becomes dark[1]. Further factors are: prolonged time of fasting, fatigue caused by the transport and/or the joining of animals not familiar to each other[1]. Other studies report that sex, implant treatments and environmental temperature beside others, contribute to the occurrence of DFD meat[3-5]. The objective of this study was to evaluate the relationship between ante mortem management factors and the occurrence of dark-cutting meat in beef cattle.

MATERIALS AND METHODS

The study was carried out in a local feedlot and in the installations of a Federal Inspection Type slaughter plant, located at 32°40' N and 115°28' W, at an altitude of 10 m above sea level, with annual mean precipitation less than 100 mm and annual mean temperature of 15°C. The site has desert dry climate. During the months of December to March, five random visits to the feed yard were made, where a questionnaire per visit was applied in order to register the information, related to all the managing practices carried out in the area of the feed yards, those of transport previous to slaughter (ante mortem) and those at the slaughter plant (post mortem) on carcasses. In order to analyze, the information generated was classified in four sections: Feed yards, transport, rest yard at the slaughter plant and area of slaughtering.

Description of study area: In the feedlot, an annual average of 21,000 animals is handled, with a monthly mean

Table 1: Variables evaluated at the four stages of animal handling

Stage	Variable	Category	
Feed yards	Driving time (min)	≤ 35	> 40
	Environmental temperature during driving (°C)	≤ 15	> 16
	Relative humidity during driving (%)	≤ 15	> 22
	Manner of driving (on)	horseback	foot
	Use of instruments for driving	yes	no
Transport	Transportation time (min)	≤ 35	> 35
	Animals joined from various stockyards	no	yes
	Number of animals per trip	≤ 35	> 40
	Cleanness of the vehicle cage	dirty	clean
	Use of club to get animals on the truck	yes	no
	Traffic during transport	little	much
	Use of club to get animals off the truck	yes	no
Rest yard at the slaughter plant	Time in the rest yard (min)	≤ 15	> 40
	Environmental temperature (°C)	≤ 19	> 20
	Relative humidity (%)	≤ 24	> 30
	Use of club for herding	yes	no
	People participating in herding	1	≥ 2
	Time of rest before slaughter (min)	≤ 18	> 30
	Total waiting time from arrival to slaughter (h)	≤ 13	> 14
	Average time to enter state of insensitivity (min)	≤ 1.3	> 1.5
Area of slaughtering	More than one blow being insensitive	yes	no
	Average time between insensitivity and slitting throat (min)	≤ 1.2	> 1.3
	Environmental temperature during slaughter (°C)	≤ 18	> 18
	Carcass refrigeration time (h)	≤ 12	> 15
	Carcass in blankets	yes	no
	Use of foggers in the cold room	yes	no

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

Type of meat	pH	L*	C*
Normal	5.4 to 5.8	40 to 60	> 30
Dark	< 5.8	< 40	< 30
DFD	≤ 5.8	< 40	< 30

Kauffman *et al.*[9], Forrest *et al.*[10] and Romans *et al.*[11]

slaughter inventory of 1,700 animals. The animals start weighing between 180 and 220 kg and are subjected to the following management practices: Vitamin treatment, deworming and implanting. Afterwards the cattle are grouped according to their weight in corrals up to 100 animals capacity. The animals are subjected to an intensive feeding program integrated by five diets, until reaching a mean weight of 480 kg at slaughtering.

Management previous to slaughter: The activity begins in the morning, when environmental temperature fluctuates between 8 and 20°C, with relative humidity between 30 and 55%. The animals are selected among several stockyards according to their body conformation made by the veterinary and other help in the exploitation and driven by a herdsman on a horseback to the area of the scales, where they are weighed and then confined to an annexed corral. From there they are shipped in trucks with cattle boxes of 16 ton capacity and transported to the slaughter plant, located at an average distance of 9 km. At the arrival to the slaughtering house, the animals are put into a rest yard, where they are kept for about 2 h until the moment of slaughtering.

Variables under study: A total of 26 management variables, such as factors predisposing to stress, were evaluated (Table 1). In order to estimate the proportion of DFD meat, a random sample of 233 carcasses was taken, considering an estimator of p = 0.1, generated from a pilot sampling[6], reliability of 95% and precision of 5%[7]. After slaughtering, the carcasses between 18 and 24 h post mortem were evaluated regarding the *Longissimus dorsi* muscle between the 11th and the 12th rib, taking the values of pH and color (L*, a* and b*). The pH was measured with a Delta TRAK ISFET pH 101 puncture portable potentiometer and color values (L*, a* and b*) were measured by a Minolta CM-2002 spectrophotometer (Minolta Camera. Co., Ltd. Japan), using the included Specular Component (SCI), a D_{65} illuminant and a 10° observer; L* determines luminosity (0 = L* = 100), a* intensity of red and b* intensity of yellow color. The Chroma values was calculated as $C = (a^{*2} + b^{*2})^{05}$ (Yong *et al.*[8]. Meat was classified as normal, dark and DFD (Table 2), applying the criteria established by Kauffman *et al.*[9], Forrest *et al.*[10] and Romans *et al.*[11]. Due to the fact that dark meat did not turn out as classified meat, these values were not included in the analysis, so that only the results of normal meat were contrasted with DFD meat.

The relationship between management factor and the occurrence of DFD meat was determined through Odds Ratio (OR) estimated by 2x2 contingency tables. The analysis was made utilizing the FREQ procedure of the SAS software[12].

Table 3: Odds ratio (O.R.) values together with their intervals of reliability by 95 % for management factors associated to DFD meat occurrence

Variable	OR	Value of reliability by 95%	
Time of getting cattle on the transport	10.53	1.37	80.42
More than 35 minutes			
Less than 35 minutes			
Environmental temperature during driving	9.51	1.24	72.68
Above 16°C			
Below 16°C			
Instruments for driving	20.25	1.20	340.28
Plastic stick			
Buzzer			
Animals joined from different stockyards on the transport	34.23	2.04	574.22
Animals mixed			
Animals of one corral only			
Waiting time in rest pen	11.13	3.80	32.60
> 40 min [a/]			
7 to 16 min			

[a/]Real time mean = 19 h

RESULTS

The percentage of DFD meat observed was 8.15%. The results of the analysis of the significant variables ($p<0.01$) per management section are shown in Table 3, together with odds ratio and intervals of reliability by 95%. The variables registered in the section of feedlot, whose management factors were associated to DFD meat, were: more than 35 minutes time for getting the animals on the transport; environmental temperature during driving above 16°C and the use of a plastic stick for herding the animals. During the transport section, the factor most related to DFD meat was joining animals of different stock pens for transport; whereas keeping the cattle longer than 19 h waiting in the rest yard, is another factor affecting meat quality condition.

DISCUSSION

The values of DFD meat observed are higher than those of 1.7% reported by Kreikemeier and Unruh[13] and those of 5%, by Janloo *et al.*[14]. In a study carried out by Kreikemeier *et al.*[15], the lowest percentages of DFD meat were observed during the months of October to February, ranging from 0.43 to 0.69%. Grandin[3,16] report that there is a rather high proportion of DFD meat in very cold climates combined with precipitation, due to a growing percentage of body heat loss and shivering. Scanga *et al.*[5] mention that in order to reduce the occurrence of DFD meat it is necessary to take decisions on animal handling time, especially, when extremely hot/cold climates or prolonged fluctuations in temperature occur. Besides, point out that animals, being treated positively by the herdsmen at the moment of handling, are less afraid of people and easy to handle when they are led towards weighing and transport, reducing stress in the animal. In this study, handling time longer than 35 minutes was basically due to a deficient distribution of the animals into weight groups at the beginning of the fattening period, which provoked greater stress in the cattle at the moment of selection for slaughter by physical conformation, because of the people, responsible to select and assemble the animals of various groups, losing time delaying the herdsmen's work at driving them to the transport.

Warris[1] indicates that putting animals, that are not used to each other, together before slaughter, mostly provokes the occurrence of DFD meat, because of the physical effort associated to agonistic behavior, besides a prolonged time in the rest yards at the slaughter plant Kreiemeier[15].

CONCLUSION

Any managing practice before slaughter may cause stress in the animal, favoring the occurrence of DFD meat. The management factors, that mostly caused stress in animals and therefore are related to the occurrence of DFD meat, were: the time necessary to get the cattle on the transport, environmental temperature during handling, the instruments to be used for cattle driving, putting animals of different stockyards together during the transport and keeping them in the rest yards at the slaughter plant for more than 19 h. Changes in ante mortem managing practices are suggested in order to minimize the occurrence of DFD meat.

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