EVALUATION OF SPRAY-CHILLING SYSTEM ON MASS LOSS AND SURFACE BACTERIOLOGY OF BEEF CARCASSES.

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Background

The average of weight loss due to evaporation in conventional air chilling, can be above 2% for carcasses of 210 Kg with a medium covering fat (Kerens and Visser, 1978). The spraying of carcasses in industrial plants, during the conventional air chilling process, has the larger purpose of decreasing weight loss. According to Allen *et al.* (1987) and Jones *et al.* (1988) the carcasses spraying during the conventional air chilling reduces the weight loss due to the evaporation process in 0,5 to 1,5% during the first 24 hours post-mortem. In agreement to Jones and Robertson (1988) the spraying or the water application over the beef carcasses in intermittent periods, was adopted by most of North America abattoir plants, with the purpose of reducing weight loss during the period of chilling. Without committing legal aspects, the spraying during the chilling was adopted in 1987 by the major part of bovine abattoir plants in the United States, in order to reduce carcasses weight loss due to high air velocity, adopted in the conventional air chilling process (Strydom and Buys, 1995). The Directive 6330.1, of FSIS – Food Safety and Inspection Service normalize the process of spraying beef carcasses (FSIS, 1993). In relation to the bacteriological quality of spray-chilled carcasses, Greer and Dilts (1988) informed that in some circumstances the spray-chilling lightly reduced the bacterial count. Greer and Jones (1997) verifying the quality and the bacteriological consequences of the spray-chilling on the beef carcasses, affirmed that, except for the color, the process did not affect the meat quality, that lasted from 4 to 16 hours.

Objectives

The present assay intended to verify the effect of the conventional air chilling system associated to the spray-chilling on the weight loss and in the bacteriological quality of beef carcasses.

Methods

The experiment was developed by the Food Research Center – FRC - of the Veterinary School of Goiás Federal University, in two different units of bovine abattoir plants located in Goiânia city. During the period from March to April 2000, the experiment took place in the unit A, and, from March to April 2001, in unit B. The system sprayed water previously chilled to a maximum temperature of +2 °C on the carcasses sides, in an intermittent way, commanded by a controlled logical program, in cycles of 90 seconds, in intervals of 30 minutes, for 4 hours, with counting of time started when the chilling room was closed. The chilling room temperature were set to 0°C ± 1°C, for 24 hours, both in control and treatment groups. Carcasses were randomly sampled, being 61 side-carcasses for the treatment group and 61 for control group in unit A, and 72 for each group in unit B. The carcasses were submitted to sampling in alternate days, being 10 of each group per day. The carcass sides were weighted before and after the process of chilling. Samples for bacteriological analyses were obtained by the smear surface swab technique, using metallic cast of 100 cm^2, applied in three different points at the carcass side, outside round, loin, and shoulder, in unit A and, in only one point of the carcass side, outside round, in unit B. In unit A, the three points constituted an only sample. The swabs employed in the collection of samples for the smear surface technique were placed in tubes containing 5 mL of peptone water 0,1%, and led to the laboratory of microbiology of FRC. The following analyses were realized: Count of aerobic psychrotrophic microorganisms, Determination of the Most Probable Number (MPN) of fecal coliforms and Standard Plate Count of aerobic mesophilic microorganisms (SPC). The SPC was done in 14 samples from unit A, and in all samples from unit B. All the bacteriological analyses were based on methodology described in "Methods of Microbiological Analysis for Food" (Brasil, 1999). All the spraying water quality, as temperature, pH, chlorine dosage and microbiology, were monitored to insure the veracity of the results. The average values and standard error were calculated for the studied variables. In the comparison of the averages, it was used the Student's *t* test, and for some variables, the logarithmic transformation of the original data took place.

Results and Discussion

The average weight values of hot and chilled carcass from the control and treatment groups, as well as its differences or weight loss, are in Table 1. The evaporation weight loss verified in the control group of units A and B, 1,39 and 1,54%, respectively, is below the described values by Kerens and Visser (1978), that mentioned weight loss above 2,0%. However, these values are inside the limits from 0,75 to 2,0%, pointed for Kastner (1981) for beef carcasses chilled by the conventional air system. It is observed in Table 1 that the average values of weight loss in the treatment group were lower to the ones verified in the control group, in both units. The difference observed in the weight loss among the units A and B, in the chilled carcasses, 0,39 and 0,96%, respectively, can be related to the fat covering the carcasses, besides the characteristics of relative air humidity and air velocity in the chilling room of each unit. It is verified, in Table 1, the existence of highly significant difference ($p < 0,001$) between the weight loss of the control and treatment group, in both units. The evaporation weight loss verified in the treatment group of unit B, 0,96%, is in agreement with information of Allen *et al.* (1987) and Jones *et al.* (1988), which informed that spray-chilling reduces the carcasses weight loss due to evaporation process in 0,5 to 1,5% in the first 24 hours. The average values of weight loss in the treatment group, in both units, also are similar to results founds by Greer *et al.* (1990), which reported a significantly reduction on mass loss ($p<0,001$) from 1,33% to 0,28% when the spraying was associated to conventional air chilling. This means that the process of spray-chilling beef carcasses can be considered advisable in economical terms. Making a projection for unit A, that had weight loss reduced from 1,39 to 0,39%, considering the slaughter of 600 animals/day, with average weight of 125 kg/hot carcass side, it probably would stop losing about 1.500 kg/day. It is known that the conventional chilling process associate to spraying of cold water on the carcasses sides, presents advantages not only to the decrease of the weight loss, but also in the increase of velocity of temperature decrease of the carcasses sides, what contributes in some conditions to reduce growth and, consequently the bacterial count (Greer and Dilts, 1988). The surface bacteriological results from the carcasses are in Table 2. It is verified that in unit A, the average values of the SPC and counts of psychrotrophic microorganisms, as well as the determination of the MPN of fecal coliforms, in swabs of the carcasses sides, did not differ to each other in a significant way ($p > 0,05$). These results find back-up in Greer and Jones (1997) that, studying the bacteriological quality of sprayed beef carcasses, affirmed that it was not affected by the process from 4 to

16 hours. In unit B, the average values of SPC and psychrotrophic counts, from swabs of carcasses sides, presented a significant difference to each other ($p < 0,05$), showing a high decrease in the average values of the treatment group. The average values of determination of NMP of fecal coliforms, in both groups, did not show a significant difference to each other. The average values verified in units A and B, for the three variables, can be considered low, and show the good hygiene conditions that prevailed in the moment of the slaughter. From the analysis of Table 2, it can be inferred that the conventional process of chilling associated to the spraying of the carcasses, and the good conditions of hygiene of the establishments before, during and after the slaughter contributed to obtain counts and determinations of indicative microorganisms that can be considered low. It is noticed that the spraying process did not commit the bacteriological quality of the meat, providing the opposite, better quality than in the carcasses that were not sprayed. Such fact can be mainly related to the effects of the superficial wash, and to the water quality. However, the importance of the continuous monitoring of the system must be emphasized, considering that each abattoir unit possesses its own characters related to hygiene, crew, physical structure and equipments. The American directive and also the Canadian establish sampling plans, looking for the control of the process in the part of the Service of Inspection.

Conclusions

We can conclude that there are remarkable differences in the average reduction of weight loss, indicating potentially economic advantages of the conventional process of chilling associated to spraying. The conventional process of chilling associated to spraying beef carcass did not change the physico-chemical quality and provided a reduction of counts and determinations of bacteriological indicators of meat.

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Table 1: Average values of weight and of its differences obtained for hot and chilled carcasses from the control and treatment groups, in the units A and B

Unit	Control Group				Treatment Group			
	HC[1]	CC[2]	Difference		HC	CC	Difference	
			kg	%			Kg	%
A - Average values	125,92	124,17	1,75[a]	1,39	125,00	124,51	0,49[b]	0,39
B - Average values	121,90	120,01	1,88[a]	1,54	121,34	120,17	1,17[b]	0,96

[1] HC: Hot Carcass
[2] CC: Chilled Carcass
[a] Values followed by different letters in the line, in the same unit, differ to each other significantly (Student's *t* Tests, $p < 0,001$).

Table 2: Distribution of the average values of SPC, psychrotrophic counts and MPN of fecal coliforms, from swabs of carcass sides of units A and B.

Variables	Parameters	Unit A				Unit B			
		Control		Treatment		Control		Treatment	
		CQ[1]	CR[2]	CQ	CR	CQ	CR	CQ	CR
SPC (CFU/cm^2)	Average	8,75	17,36[a]	19,40	22,48[a]	9,99	116,19[a]	22,60	16,23[b]
	Standard error	5,02	8,12	7,63	14,12	1,14	82,91	8,15	4,13
Psychrotrophic (CFU/cm^2)	Average	7,79	9,23[a]	2,15	5,09[a]	77,34	21.460,67[a]	3,63	21,99[b]
	Standard error	4,09	4,72	0,68	1,46	75,69	21.428,12	1,28	15,71
NMP of fecal coliforms (germs/cm^2)	Average	3,03	3,00[a]	3,02	3,00[a]	0,45	0,36[a]	0,33	0,31[a]
	Standard error	0,02	0,00	0,02	0,00	0,13	0,06	0,02	0,01

[1] HC: Hot Carcass
[2] CC: Chilled Carcass
[a] Average followed by same letter in the line, in the same unit, don't differ to each other significantly (Student's *t* Test, $p>0,05$).