SHRINKAGE AND MUSCLE QUALITY IN SPRAY-CHILLED BEEF CARCASSES

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SUMMARY

Four experiments were conducted to examine the effects of an intermittent water spray during cooling on beef carcass yield and muscle quality. Experiments 1, 2 and 3 used 4, 8 and 12 hour periods of an intermittent water spray (4 cycles per hour with a spray duration of 60 seconds) applied to shrouded carcass sides compared to control sides with no spray applied. Experiment 4 used the same procedure as experiment 2 except that unshrouded sides were used. Side weight shrinkage at 24 hours following slaughter was significantly reduced ($P < .01$) by 0.48, 0.69, 0.89 and 1.43% in experiments 1-4 for spray-chilled compared to control sides. Most measures of muscle quality were similar for treated or control sides, except that fat colour became lighter with a longer period of spray-chilling. Drip losses and colour changes were similar for meat displayed in retail packages for 4 days irrespective of treatment. It was concluded that spray-chilling was effective in reducing carcass cooler shrinkage and had no obvious detrimental effects on muscle quality.

INTRODUCTION

Typical weight losses in beef carcasses over the first 24 hours post slaughter range from 0.75-2.0% (Kastner 1981) in North America and from 1.2-1.7% in the U.K. (Collett and Gigiel 1986). Allen et al. (1987) reported that carcass shrinkage over 24 h was reduced from 1.46 to 0.32% when unshrouded carcasses were spray-chilled for 8 h (32 cycles of 90 seconds duration every 15 min.), but purge (drip) was marginally increased (0.26%) in vacuum packaged inside rounds.

The objectives of this study were to: 1. Determine shrinkage losses in sides of shrouded and unshrouded beef spray-chilled for various times during cooling; 2. Evaluate the possible influence of spray-chilling on muscle quality, carcass and primal cut shrinkage during storage and subsequent retail display.

EXPERIMENTAL METHODS

Four separate experiments were conducted over a period of 5 months. Experiment 1 used 19 shrouded carcasses and alternate sides were placed in one of two coolers with identical conditions (temp. 1°C, air velocity 0.5 m/s), to have equal numbers of left and right sides within each treatment. Carcass sides were spray chilled with water (average temperature 12°C) for a period of 4h (4 cycles/h; 60s duration) and held in the cooler for another 20h, so that total chilling time amounted to 24h. Carcass sides placed in the second cooler were air chilled only for 24h and served as controls. Shrouds were removed at the end of the spray-chilling period. Experiments 2 and 3 followed the same procedures as described for experiment 1 except that the duration of the spray-chilling treatment was increased to 8 and 12h, respectively. Experiment 4 examined the effect of 8h of spray-chilling compared to control sides without the use of a shroud.

Half the treatment and control sides (where permitted by the design) were fabricated about 30h post-slaughter into the major primal cuts and two subprimal cuts (boneless rib - IMPS 112; inside round - IMPS 168) were vacuum packaged in high oxygen barrier film bags (oxygen transmission rate of 10 cc/m^2/24h at 37.8°C and 90% RH) and held at 2°C for 6 days. The whole sides remained in a holding cooler for 6 days, and the same subprimals removed. Two rib steaks 28.5 mm thick were removed from each rib (from side or vacuum package) and placed in separate polystyrene trays overwrapped with an oxygen permeable wrap, and held at 2°C for 4 days to simulate retail display. Two roasts weighing approximately 1 kg, were prepared from the inside round and packaged and held in the same way as described for the rib steaks. Meat colour for the LD and overall fat colour were measured at the cut surface of the LD using a Minolta Chroma Meter II (Minolta Camera Company, Meter Division, Ramsey, NJ., USA) at 24h post-slaughter. On day 11 post-slaughter a 28.5 mm rib steak from each side was cooked to an internal temperature of 80°C in a microwave oven and held overnight at 2°C. After equilibration to room temperature (20°C), two cores of 19mm were removed and sheared using the Ottawa Texture Measuring System (Canners Machinery, Simcoe, Ontario, Canada) equipped with a Warner-Bratzler cell. Data collected in this study were analyzed using analysis of variance procedures.

Table 1. Effects of spray-chilling on carcass shrinkage and drip in vacuum packaged cuts

	Time of Spray-Chilling, h							
	0	4	0	8	0	12	0+	8+
Side wt. kg	126.6	126.6	137.6	137.2	142.1	141.8	129.7	129.7
Shrinkage %:								
End of spray	.83^a	.09^b	.79^a	.18^b	.90^a	.26^b	1.26^a	.72^b
To 24h	1.63^a	1.15^b	1.29^a	.60^b	1.29^a	.40^b	1.78^a	.35^b
To 6 days	3.53	3.24	2.60	2.26	2.66^a	2.19^b	4.16^a	3.22^b
Drip %:								
Rib,6 days	.38	.41	.31	.36	.34	.36	.40	.41
Round,6 days	1.30	1.28	1.02	1.18	1.05^a	.88^b	.92	.91

+ Unshrouded sides ^{ab} Means within a spray chill treatment are significantly different ($P<0.01$)

Table 2. Effects of spray-chilling on muscle quality and carcass fat thickness

	Time of spray chilling, h							
	0	4	0	8	0	12	0+	8+
Meat colour								
% Y	8.59	8.54	7.92	7.67	8.39	8.19	8.19	7.58
Fat colour								
% Y	39.9	41.7	39.3a	45.8b	42.1a	50.6b	34.4a	40.0b
Shear, kg	6.9	6.5	7.7	7.3	7.0	6.9	7.3	8.4
Fat, mm	4.1	4.7	5.2	5.4	6.1	6.5	5.4	5.6

+ Unshrouded sides. [ab] Means within a spray chill treatment are significantly different ($P<0.01$)

RESULTS

Spray chilling significantly reduced carcass shrinkage at the end of the spraying period and this result continued through to 24h post-slaughter (Table 1). After 6 days of cooler ageing total shrinkage in carcass weight was similar for sides spray-chilled for 4 and 8h, respectively. However, sides that were spray-chilled for 12h and unshrouded sides spray-chilled for 8h had significantly lower carcass weight shrinkages to 6 days than control sides. Drip or purge losses over 6 days in vacuum packaged ribs and inside rounds tended to be similar whether the sides were spray-chilled or not (Table 1).

Muscle colour was not influenced by the spray-chilling treatments although it should be noted that there was a trend for the LD from spray-chilled sides to have slightly lower C.I.E. Y values than those from control sides (Table 2). Fat from spray-chilled sides where the spraying period was 8h or more had significantly higher Y values than control sides. Muscle shear values and carcass fat thickness were not influenced by spray-chilling.

Weight losses, % drip and colour changes of rib steaks and round roasts held in retail packages for 4 days were largely unrelated to spray-chilling.

DISCUSSION

Spray-chilling was found to have a highly significant effect on carcass shrinkage, particularly in the first 24h following slaughter. Carcass shrinkage at 24h was proportionally related to the length of the spray-chilling treatment, so that shrinkage was reduced by 0.48-0.89% as the spray-chilling period was increased from 4 to 12h. Allen et al. (1987) reported a shrinkage saving of 1.14% in unshrouded carcasses sprayed for 8h, which is similar to our results. The 6 day shrinkage data reveal that spray-chilling becomes a less effective method to conserve weight loss over a period of time. Drip losses in cuts that had been vacuum packaged did not appear to be influenced by spray-chilling. Allen et al. (1987) essentially found similar results except for inside rounds where purge or drip was increased by 0.26%, after 15 days of storage. Hamby et al. (1987) reported that spray-chilling (2 cycles of 30 secs. /h for 12h) had no effect on purge in various cuts after 28 days of vacuum packaged storage. Loin muscle colour at 24h post-slaughter was not influenced by spray-chilling, although luminosity (Y) always tended to be lower in treated compared to control sides. Allen et al. (1987) also found that spray-chilling had no effect on loin muscle colour. Fat colour in sides spray-chilled for 8 and 12h was whiter than control sides based on objective measurements of colour. This difference was visually apparent and has not been previously reported in the literature. Retail cuts held for 4 days generally tended to have similar weight losses and colour changes which were independent of treatment.

CONCLUSIONS

This study has demonstrated that spray-chilling can substantially reduce carcass shrinkage particularly during the 24h period that elapses following slaughter. The longer the spray-chilling period, the greater are the potential savings in shrinkage. However, some caution should be used in interpreting these results. Jones et al.(1988) found that spray-chilling pig carcasses reduced shrinkage over 24h by 2.4%, but that the majority of this saving (60%) was in reduced subcutaneous fat weight loss during cooling. If a similar mechanism exists in beef carcasses then the spray-chilling process is mainly conserving evaporative weight losses in subcutaneous fat. Although the savings in shrinkage attributed to spray-chilling are substantial over 24h post-slaughter, much of this saving in weight loss may well disappear in additional fat trim which has a low value compared to meat in typical vacuum packaging operations. On the other hand, slaughter plants merchandizing whole carcasses within 1 day of slaughter would realize large benefits by utilizing the spray-chilling process.

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