The relationship of bloom to washing, bacterial numbers and animal type (cows, heifers, steers) in beef carcasses

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Introduction

The interest of Irish meat exporters in carcass bloom arises from the down-grading of beef sides on the British market. This was highlighted by O'Connell *et al.*, (1981) who found that poor bloom resulted in a discount in the wholesale meat price. These authors state that carcass bloom is not a precisely defined phenomenon. Since it is a subjective assessment of quality, an accurate definition in terms of known physical parameters, is difficult. In the past some attempts have been made to describe bloom in this way and to determine the factors responsible for its deterioration.

According to Hicks *et al.*, (1956) bloom is affected by the rate and extent of water loss from the meat during chilling and storage. A relatively high rate of evaporation during chilling has been suggested by Scott and Vickery (1939) as being conducive to the retention of good bloom. A series of experiments carried out by Locker *et al.*, (1978) showed that drying lamb carcasses gave good bloom and that this could be related to a tight compressed surface structure as a result of desiccation of the meat. Undried wet meat did not have this compressed structure but had sizeable cavities among the outer muscle layers. These comments cannot be taken as an indication that indiscriminate drying of carcasses will give good bloom. They do emphasise the necessity of having an evaporation rate which will allow the surface to dry, but not excessively.

While some desiccation is necessary, excessive drying of the carcass must be avoided, otherwise the superficial appearance or bloom, will deteriorate rapidly (Nottingham, 1971; Lawrie, 1979). Griffiths *et al.*, (1932) noted that loss of bloom was essentially the result of changes in the superficial tissues, due mainly to excessive evaporation or sweating. The latter condition causes swelling of the collagen fibres, which become white and opaque, resulting in poor bloom. This may be reversed by chilling (Lawrie, 1979). Excessive desiccation results in the formation of minute air cells amongst the dried muscle fibres. The scattering of light from the interfaces so formed decreases the depth from which the light is reflected and the muscle appears to have a lighter hue and loss of bloom (Hicks *et al.*, 1956).

The present investigations were undertaken to determine the influence of washing, bacterial numbers and animal type on beef carcass bloom. While the refrigeration being used in the plant was monitored no efforts were made to define the optimum chilling conditions for good bloom.

Materials and Methods

Carcasses were selected in a commercial export plant in the following way. The 87 cow sides used had a conformation class of O (90%) or PA (10%), a fat cover of 3 (28%), 4L (67%) or 4H (5%) and a mean side weight of 140 kg (range 128-157 kg). The 37 heifers used had a conformation class of R (22%) or O (78%), a fat cover of 2 (22%) or 4L (78%) and a mean side weight of 136 kg (range 116-159 kg). The 38 steers had a conformation class of R (55%) or O (45%), a fat cover of 3 (47%) or 4L (53%) and a mean side weight of 147 kg (range 124-166 kg). The average age of the cows was judged to be about 6 yrs (range 2-9 yr), and that of the heifers and steers about 2 yrs (range 1½-2½ yrs), based on the numbers of permanent teeth and the amount of wear. The carcass classifications and ageing of animals were carried out by personnel from the Department of Agriculture. Except where specifically stated, all experiments were with cow carcasses.

The temperature of the holding chills and the deep round of the carcasses were monitored at 1 h intervals, using a Solartron 3430 logger. The relative humidity (R.H.%) of the air was calculated from wet and dry bulb measurements using the same instrument. Air velocity (m/sec) was measured in different locations in the chill using a hand-held anemometer (Air flow developments, Model AM 5000). Weight loss was estimated by weighing carcasses on a previously calibrated commercial scales and again after chilling.

Carcasses used to assess the effect of washing were split into two sides, one of which was sprayed with water at 40°C and subsequently cleaned using a nylon brush. The other side was left untreated.

Bacterial numbers were assessed using swabs from four 25 cm^2 sites, representing 2 areas with high (neck and inside round) and 2 areas with low (medial and sirloin flank) levels of bacterial contamination. The swabs from the four sites were pooled in 100 ml of 0.1% Oxoid peptone water (pH 7.0 - 7.2) in honey jars. Bacterial numbers were estimated on quartered surface inoculated Oxoid Tryptone Glucose Yeast Agar (TGYA) plates, containing 0.025 ml of the neat solution or successive tenfold dilutions of this. Plates were incubated at 25°C for 3 days and 14 days at 4°C.

The bloom of the carcasses was assessed at up to 4 different times by judges from the meat plant and by the Agricultural Officers. They were asked to evaluate each carcass for bloom and to score them from 1 to 5 corresponding to 1 excellent, 2 very good, 3 good, 4 fair and 5 poor. The lower the mean score the better the bloom.

The mean bloom score (averaged over judges) was calculated for each side at each observation time, and the rate of change in bloom by regressing mean bloom score on time for any side that had two or more bloom readings. Rates of change in bacterial numbers were similarly calculated. Analysis of variance was used to compare the two treatments. Whether or not bloom score or bacterial numbers changed over time was examined by t-tests (testing if mean rate of change equals 0). Correlation coefficients were used to determine the relationship between bloom score and bacterial numbers.

Results

In the factory where these investigations were carried out, three chills were generally used to cool the carcasses. An investigation on the performance

of these chills with cattle of about similar weights and fat cover, was carried out to determine their cooling efficiencies. In general the temperature of the deep round took 36 to 40 hours to reach 7°C and the mean weight losses varied from 1.5 to 1.9% (Fig. 1). Air velocity measurements are not included in the results since they were considered very inaccurate. This arose because with air turbulence in the chill, the anemometer operated in either direction, making accurate readings impossible. The mean R.H. of the chills was from 92 to 94%.

The effect of washing and storage for 9 days on bacterial numbers is shown in Table 1. On plates incubated at 25 or 4°C there was no difference in numbers from washed or unwashed carcasses. This was also reflected in the rate of change in bacterial numbers/day which was similar for both washed and unwashed carcasses.

Bloom scores on the same carcasses at different times are shown in Table 2. Washing had no effect on bloom over the entire 9 days of the experiment. There was no correlation between washed or unwashed carcasses and bloom at any of the sampling times.

The data in Table 3 shows that there was a significant increase in bacterial numbers on carcasses over the 9 day period at both incubation temperatures. In the same time period there was no significant change in bloom.

The bloom at 0 time and again 36 hours post mortem was assessed on cows, heifers and steers (Table 4). It was shown that there was a significant difference in the bloom on cow carcasses, compared to heifers or steers immediately post mortem and before chilling ($P<.001$). There was no difference between the heifers or steers. For the three animal types, bloom did not change significantly from 0 time to 36 hours post mortem.

Discussion

The chills used in the present work would have been within the parameters for cooling to 7°C for a 140 kg carcass in a chill with an average air velocity of 2m/sec and an R.H. of 94%, as outlined by Bailey and Cox (1976). Assuming that these conditions can produce carcasses with good bloom, the chills in the present study should have similar capabilities. This was substantiated from the results on the storage of carcasses which showed no detectable deterioration in bloom over a 9 day period. Since washing also had no effect on bloom it appears that evaporation within the chills was sufficient to dry the carcasses, but not adversely affect the bloom.

The results indicated that there may also be an inherent difference in carcasses from different animal types. Although the cows were of good grade and quality, their bloom was poorer from the outset. This is considered to be a feature of age and the increasing quantity of collagen-like material and the duller colour of the fat. For the plant being used in the present investigation, this has a considerable significance, since a large proportion of its trade (40%) is in butcher cows. It is noteworthy that this difference was consistent over the 3 day period investigated.

Although bacterial numbers have been implicated in colour change in beef by other workers, there was no evidence of a relationship between bloom or bacteria in the present work (Lanier *et al.*, 1977). It was also observed that washing had no effect on bacteria on carcasses, either initially or after

storage of the sides. This has been noted previously for lamb carcasses wiped with a cloth or spray washed with water at 10°C (Kelly *et al.*, 1982).

While results on the consistency of judging of carcass bloom have not been presented here, it seems appropriate to make some comment on these. This was generally inconsistent and in many instances the subjectivity of the panel was evident by frequent contradictions of previous judgements. This was not entirely unexpected however, and has been noted previously (Kelly,1978).

Since carcass bloom on beef shipped to the UK and continental Europe from this factory continues to be poor, the subsequent handling and transportation of the product needs investigation. During transportation abuses may occur and this aspect also needs to be highlighted. Some data have already been presented on this subject, which indicated that there was scope for improvement in the temperature of carcasses before and during transportation (Kennick *et al.*, 1977). In order that the industry as a whole should benefit from such studies, the chilling conditions necessary to produce good bloom need to be clearly defined. Such a definition would have to incorporate the complete chilling regime, including transportation.

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TABLE 1: The effect of washing and storage in a chill for 9 days on bacterial numbers (log_{10}/cm^2) on beef carcasses

Carcass storage time (days)	Carcass treatment		Residual D.F.	Standard error of difference between means
	Washed	Unwashed		
	(a)*			
0	3.32	3.09	24	0.23
3	3.61	3.65	24	0.18
6	4.40	4.01	10	0.34
9	5.72	5.76	10	0.27
Rates of change in bacterial numbers/day	0.13	0.22	24	0.07
	(b)			
0	2.99	2.90	24	0.21
3	3.17	3.21	24	0.23
6	4.90	4.54	10	0.52
9	5.52	5.73	10	0.26
Rates of change in bacterial numbers/day	0.19	0.23	24	0.08

*(a) plates incubated at 25°C
(b) plates incubated at 4°C

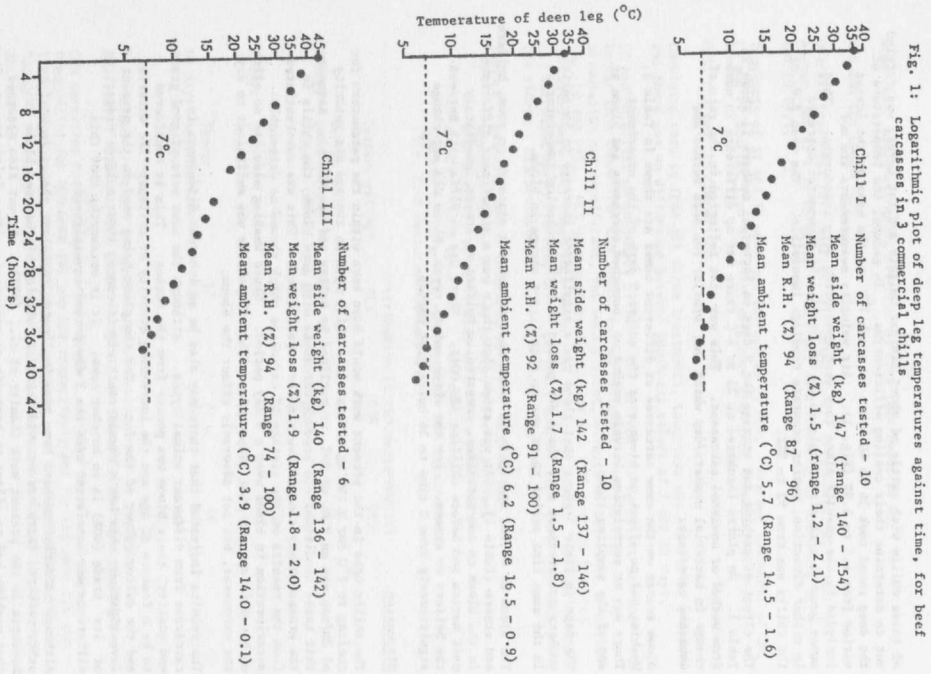

Fig. 1: Logarithmic plot of deep leg temperatures against time, for beef carcasses in 3 commercial chills

TABLE 2: The effect of washing and storage in a chill for 9 days on the bloom of beef carcasses

Carcass storage time (days)	Carcass treatment		Residual D.F.	Standard error of difference between means
	Washed	Unwashed		
0	2.99	3.05	26	0.20
3	3.06	3.09	46	0.18
6	3.45	3.17	18	0.24
9	3.28	3.17	18	0.36
Rate of change in bloom/day	0.04	-0.02	26	0.04

TABLE 3: Mean rate of change/day in bacterial numbers/(log_{10}/cm^2) and bloom on beef carcasses stored in a chill for 9 days

Incubation temperature (°C)	Mean rate of change in bacterial numbers/day	Standard error of means	Residual D.F.	t-test
25	0.17	0.03	48	P<.001
4	0.21	0.04	48	P<.001
Mean rate of change in bloom/day	0.01	0.018	28	N.S.

TABLE 4: Bloom in cows, heifers and steers immediately post slaughter and after storage for 36 h in chill

Type of animal	Cows	Heifers	Steers	Maximum standard error of difference between means	F-test
Time (h) of bloom assessment					
0 - 1	3.17	2.83	2.71	0.11	P<.001
	(39)*	(37)	(38)		
36	3.27	2.78	2.69	0.13	P<.001
	(32)	(35)	(24)		
Change in bloom	0.09	-0.03	-0.04	0.12	N.S.
	(32) N.S.	(35) N.S.	(24) N.S.		

*Numbers of observations

N.S. = not significant