Evaluation of carcass hygiene in sheep subjected to gas de-pelting with different skinning procedures

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Abstract

The aim of the study was to evaluate the hygienic status of sheep carcasses skinned with two different procedures, the *pulling down* and *Y cut* methods, with and without the use of compressed filtered air inflation. Five sheep carcasses per day for each of the four skinning methods considered were sampled on ten different slaughtering days using wet and dry swab techniques at a local abattoir specialised in ovine slaughtering. A pool of four different sampling sites (brisket, shoulder, thorax and rump) was considered for each animal. Furthermore, ten animals were also randomly selected on different slaughtering days for each of the four skinning techniques and the four sampling sites were separately swabbed and analysed in each animal. The total viable count (TVC) and *Enterobacteriaceae* count were performed and the presence of *Salmonella* spp. was also tested. The daily average mean value of each parameter was in compliance with limits set by Regulation (EC) 1441/2007, falling into satisfactory or acceptable category for *Enterobacteriaceae* and within the acceptable level range for TVC for both the methods used with and without air de-pelting. For both TVC and *Enterobacteriaceae* count, no statistically significant differences (P>0.05) were recorded between samples obtained from carcasses skinned with and without air inflation for either of the skinning methods used and any of the sites sampled. No *Salmonella* spp. were detected in any of the tested samples. Nonetheless, no improvement in the carcass hygiene was detected either and, for this reason, other aspects should be taken into consideration when considering adopting the gas de-pelting method.

Introduction

The carcass surface is unavoidably contaminated during the slaughtering of meat producing animals. Operators' hands and knives that are not sterile come into contact with the carcass and transfer bacteria to its surface, during bleeding, pelting, evisceration (Hadley *et al*., 1997) and *post-mortem* inspection (Walker *et al*., 2000). The most frequently involved step among the above mentioned procedures is skinning, especially of unsheared sheep and lambs, when bacteria present in the hide can spread to the carcass not only by cross-contamination but also by direct contact of the carcass surface with the fleece (Biss and Hathaway, 1996). Reducing the possibility of surface contamination is very important and, for this reason, an appropriate de-pelting method is crucial to assure the hygienic status of the carcasses. A number of methods that facilitate the skinning process while ensuring carcass hygiene have been reported (European Commission, 2001b), among which de-pelting using inflation of filtered compressed air is found. Air inflation is a method commonly used in Italy (Severini, 1996) allowed by EC Directive 95/23 (European Commission, 1995) only for skinning of lamb of live weight under 15 kg, when the hygienic conditions of the procedures are checked and approved by the official veterinary inspector. In Regulation (EC) 853/2004 (European Commission, 2004) the use of air inflation is not mentioned anymore. Few data about differences in the hygienic status of carcasses de-pelted with and without air inflation, mainly for lambs, are present in the literature (Trevisani *et al*., 1996; Severini *et al*., 2000). The aim of this work is to evaluate the hygienic condition of adult ovine carcasses (of live weight over 15 kg) skinned using two different methods with and without the use of filtered compressed air. A comparison between the data obtained and the process hygiene criteria set by Commission Regulation 1441/2007 (European Commission, 2007) is also drawn.

Materials and Methods

The study was conducted in two separate steps. In the first step the hygienic status of carcasses skinned with two different dressing procedures, the *pulling down* and *Y cut* methods (Table 1; Figure 1) with and without the use of compressed filtered air inflation [exercise pressure 900 kPa for 10-15 sec; 0.01 m aseptic filter mod.; Ethafilter s.r.l., Sovizzo (VI), Italy], was determined. Air was inflated from the forelegs before or after the removal of the front hooves. On ten different days, five sheep carcasses per day for each of the four skinning methods were sampled at a local abattoir specialised in ovine slaughtering. A pool of four different sampling sites (brisket, shoulder, thorax and rump) was considered for each animal. Wet and dry swab techniques, as described in standard ISO 17604 (ISO, 2014), were used over a 100 cm^2 area delimited by a sterile template for each sampling site (total area sampled of 400 cm^2) and swabs obtained for each carcass were collected in a single vial containing 10 mL of maxim recovery diluent (MRD; Oxoid Ltd., Basingstoke, UK). Samples were transported at refrigeration temperature to the laboratory and immediately analysed. Serial dilutions in MRD were obtained. On them, total viable count (TVC) using Plate Count Agar (Oxoid Ltd.) aerobically incubated at 30°C for 72 h, and *Enterobacteriaceae* count using Violet Red Bile Glucose Agar (VRBG; Oxoid Ltd.) aerobically incubated at 30°C for 24 h, were determined. The results were normalised to colony forming unit (CFU)/cm^2 and converted into $\log_{10}$ values. The means of the log values were then calculated for each sampling day for each skinning method. The presence of *Salmonella* spp. was determined following UNI EN ISO 6579:2008 (UNI, 2008).

The second step aimed at determining whether the use of air inflation could change surface contamination on one of the sampling sites considered. For this reason, 10 animals were randomly selected on 5 different slaughtering days for each of the four skinning techniques. In each animal the four sampling sites were separately swabbed with the above mentioned method and separately analysed. Total viable count, *Enterobacteriaceae* count and *Salmonella* spp. were determined as previously described. The results were normalised to CFU/cm^2 and converted into $\log_{10}$ values. Mean values and standard deviations were calculated

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for TVC and *Enterobacteriaceae* count. For the latter, when bacteria were not detected at the level of 1.0 CFU/cm², a value of -0.5 $\log_{10}$ CFU/cm² was assigned (Byrne *et al*., 2007). The effect of skinning with the aid of compressed filtered air was evaluated for *pulling down* and *Y cut* methods separately using the unpaired T test (Statview; SAS Inst. Inc., Cary, NC, USA) and the significance level was set at a value of $P<0.05$.

Results

Enterobacteraceae were detected in 60 and 50% of the samples for the *pulling down* method assisted with and without filtered compressed air, respectively, and for both *Y cut* methods in 70% of the samples (data not shown). The results of the first step of the trial are reported in Table 1, while those of the second step are reported in Tables 2 and 3 for TVC and *Enterobacteriaceae*, respectively. For both TVC and *Enterobacteriaceae* count, no statisti-

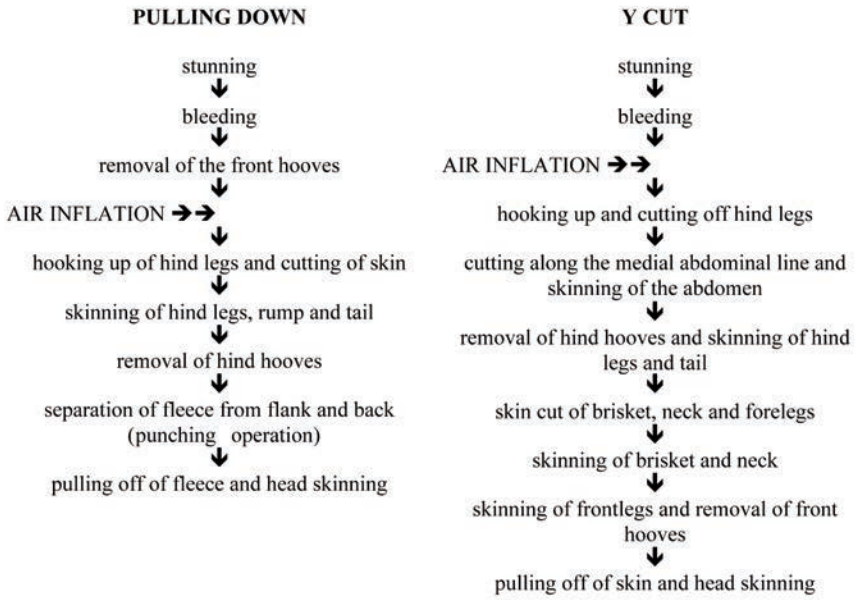

Figure 1. Flowchart of the skinning methods used in the present study.

Table 1. Total viable and *Enterobacteriaceae* counts obtained from sheep carcasses skinned by *pulling down* and *Y cut* methods with and without use of filtered air inflation: first step of trial.

Parameter	Skinning method		Samples (n)	Mean value ($\log_{10}$ CFU/cm²)	SD	P*
TVC	*Pulling down*	With air	50	3.25	0.58	0.635
		Without air	50	3.38	0.55	
	Y cut	With air	50	3.47	0.35	0.253
		Without air	50	3.31	0.26	
Enterobacteriaceae	*Pulling down*	With air	50	0.62	1.10	0.587
		Without air	50	0.36	1.02	
	Y cut	With air	50	0.75	1.05	0.886
		Without air	50	0.68	1.09	

SD, standard deviation; CFU, colony forming unit; TVC, total viable count. *Not significant at $P>0.05$.

Table 2. Total viable count obtained from different sampling sites of sheep carcasses skinned by *pulling down* and *Y cut* methods with and without use of filtered air inflation: second step of trial.

Sampling site	Skinning method		Samples (n)	Mean value ($\log_{10}$ CFU/cm²)	SD	P*
Rump	*Pulling down*	With air	10	3.23	0.47	0.279
		Without air	10	3.51	0.63	
	Y cut	With air	10	3.47	0.45	0.817
		Without air	10	3.39	0.83	
Thorax	*Pulling down*	With air	10	3.04	0.56	0.923
		Without air	10	3.07	0.62	
	Y cut	With air	10	3.21	0.43	0.809
		Without air	10	3.16	0.50	
Brisket	*Pulling down*	With air	10	3.11	0.45	0.277
		Without air	10	3.42	0.75	
	Y cut	With air	10	2.92	0.64	0.474
		Without air	10	3.17	0.87	
Shoulder	*Pulling down*	With air	10	3.01	0.70	0.516
		Without air	10	2.81	0.64	
	Y cut	With air	10	3.46	0.95	0.710
		Without air	10	3.32	0.75	

SD, standard deviation. *Not significant at $P>0.05$.

Table 3. ***Enterobacteriaceae*** **count obtained from different sampling sites of sheep carcasses skinned by** ***pulling down*** **and** ***Y cut*** **methods with and without use of filtered air inflation: second step of trial.**

Sampling site	Skinning method		Samples (n)	Mean value (log_{10} CFU/cm²)	SD	P*
Rump	*Pulling down*	With air	10	0.66	1.32	0.595
		Without air	10	0.98	1.37	
	Y cut	With air	10	1.24	1.28	0.371
		Without air	10	1.27	1.20	
Thorax	*Pulling down*	With air	10	-0.32	0.39	0.642
		Without air	10	-0.23	0.44	
	Y cut	With air	10	-0.30	0.44	0.682
		Without air	10	-0,19	0.67	
Brisket	*Pulling down*	With air	10	-0.30	0.43	0.218
		Without air	10	0.04	0.73	
	Y cut	With air	10	-0.02	0.80	0.970
		Without air	10	-0.01	0.84	
Shoulder	*Pulling down*	With air	10	0.01	0.85	0.734
		Without air	10	0,13	0.84	
	Y cut	With air	10	0.01	0.79	0.337
		Without air	10	-0,21	0,61	

SD, standard deviation. *Not significant at P>0.05.

cally significant differences were recorded between samples obtained from carcasses skinned with and without air for either of the skinning methods used and any of the sites sampled. No *Salmonella* spp. were detected in any of the tested samples.

Discussion

The results obtained in the first step of the study showed values in compliance with limits set by Regulation (EC) 1441/2007 (European Commission, 2007) for carcasses sampled using non-destructive method. In this case the Italian legislation reports that the limits set by Regulation (EC) 1441/2007 have to be reduced to 1/5 (Italian Republic, 2007), as suggested by Commission Decision 471/2001 (European Commission, 2001a) which indicates that the swab sampling removes only a part (often 20% or less) of the total flora present on the meat surface (m=2.80 log_{10} CFU/cm² and M=4.30 log_{10} CFU/cm² for TVC; m=0.80 log_{10} CFU/cm² and M=1.80 log_{10} CFU/cm² for *Enterobacteriaceae*). For both parameters the results fell into the satisfactory or acceptable category for *Enterobacteriaceae* and within the acceptable level range for both of the skinning methods with and without air de-pelting.

The TVCs were similar to those reported in the literature on ovine carcasses, even though using different slaughtering and sampling procedures (Sumner *et al*., 2003; Byrne *et al*., 2007; Nouichi and Hamdi, 2009; Phillips *et al*., 2013), or even lower than data reported by other authors (Milios *et al*., 2011). The same was observed as for the *Enterobacteriaceae* count (Lenahan *et al*., 2010). The use of air inflation in both of the skinning techniques did not affect the hygienic status of sheep carcasses, as previously reported for lambs (Severini *et al*., 2000). This result was evident both for the daily average hygienic level and for the different sampling areas, thus proving that air inflation procedure does not affect the hygiene of the carcass surface. No improvement in the hygienic condition of the carcasses was detected and, for this reason, other aspects should be taken into consideration in choosing the use of gas de-pelting in ovine, such as the time necessary for pelt removal, the appearance of the carcass surface or the reduction of skin damage (Severini *et al*., 1994). No considerations could be made for *Salmonella* spp. since all the samples were negative, as other authors also reported (Lenahan *et al*., 2010).

The use of gas de-pelting is allowed in other countries (New Zealand), where compressed filtered air can be used. Those who choose to use this method for industrial production must have an approved Hazard Analysis and Critical Control Points (HACCP) plan with microbiological monitoring for its validation (Ministry of Agriculture and Forestry of New Zealand, 2002). The present study gives further evidence that this could be a reliable method to use in Europe too, as almost all the checked lots of production obtained with air inflation satisfied the hygiene parameters set by legislation. Nonetheless, the official veterinary inspector could request further investigation on the hygiene level of the procedure when unacceptable levels of carcass surface contamination are detected and the food business operators could implement specific prerequisite programme of the HACCP system adopted. The use of air inflation could also be evaluated for other dressing systems, such as the *inverted* one (Bell and Lovatt, 1999).

Conclusions

The use of air inflation to assist ovine skinning did not increase surface contamination in adult ovine carcasses in either of the manual skinning methods used. However, the use of air inflation, in combination with mechanisation, as well as the cleaning level of the fleece in live animals transported to the slaughterhouse, still need further consideration and studies.

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