



A comparison of two evisceration methods on hygienic quality in the pelvic area of sheep carcasses



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ABSTRACT

The aim was to compare the effects of two evisceration methods under operational conditions, on the pelvic hygiene of sheep carcasses. Method 1: rectum sealed with plastic bag and pushed through the pelvic cavity. Method 2: rectum cut, placed back inside and pulled out from the carcass. The 18 largest Norwegian sheep abattoirs participated. Sampling areas were i) 400 cm² inside the pelvic cavity (n = 623), ii) 100 cm² outside the circum-anal incision (n = 622). There were pooled samples by swabbing the same area of five carcasses, representing totally 3115 carcasses. Mean *E. coli* results from Method 1: $-1.61 \log \text{CFU/cm}^2$ inside and $-0.25 \log \text{CFU/cm}^2$ for the outside area. Results from Method 2: $-1.56 \log \text{CFU/cm}^2$ inside and $-0.42 \log \text{CFU/cm}^2$ outside. There were no significant differences between the two methods. Both evisceration methods can produce carcasses that are of practically identical high hygienic quality.

1. Introduction

Good Hygiene Practices (GHP) and correct slaughter techniques at sheep slaughtering are, along with having clean animals, fundamental pre-requisites for meat safety. Sheep can be carriers of various pathogens, including *Campylobacter* spp. (Rosef, Gondrosen, Kapperud, & Underdal, 1983), shigatoxigenic *E. coli* (STEC) (Brandal et al., 2012; Urdahl, Alvseike, Skjerve, & Wasteson, 2001) and enteropathogenic *E. coli* (Martins et al., 2016), *Cryptosporidium* spp. (Robertson, Gjerde, & Furuseth Hansen, 2010), and *Salmonella* spp. (Alvseike et al., 2004; Alvseike & Skjerve, 2002). Hygienic fleece removal and evisceration of sheep is therefore important to minimise carcass contamination. The importance of slaughter hygiene is further enhanced by the fact that meat from sheep may be used in cured sausages, which are produced without heat treatment in Norway (Heir et al., 2010; Schimmer et al., 2008).

The size of the carcasses varies considerably, from below 6 kg to over 60 kg. The average weight for lambs is approximately 19 kg. This large difference in size creates challenges for the operators at the slaughter line, as large sheep and small lambs are slaughtered randomly.

Evisceration has a high risk of faecal contamination of carcasses, due to knife wounds and punctures resulting in leakage of the intestinal content. GHP for evisceration include ensuring that the risk of puncturing the viscera, alimentary tract, uterus, urinary bladder, and gall bladder is minimised during separation cuts. In addition, and regardless

of knife wounds, the two ends of the gastrointestinal tract are of considerable concern as potential sources of contamination of the carcasses.

Evisceration occurs after mechanical fleece removal. There are two prevailing techniques of evisceration, and which technique is used depends on whether the sheep carcasses are suspended by the forelegs or hind legs. In many slaughter lines, the carcasses are suspended by the hind legs. This allows use of a particular technique, “bagging”, in which a plastic bag is used to seal the rectum after circum-anal incision. The sealed rectum is then pushed inside the pelvic cavity and removed together with the intestines (referred to here as “Method 1; head down, rectum sealed”). In other slaughter lines, the carcasses are suspended by the forelegs and it is not necessary to pull the rectum through the pelvic cavity, as the rectum is loosened and pulled backwards out of the carcass (referred to here as “Method 2; head up, rectum cut”). In this method, the rectum is emptied of faeces approximately 10–15 cm from the pelvis by stroking it in the oral direction, then the rectum is cut and placed back inside the pelvic cavity. Circum-anal incision is performed, and the rectum is removed together with internal genitalia and the urinary bladder, which is pulled back and out of the carcass, thus in the opposite direction as used for Method 1.

Whether Method 2, emptying and cutting the rectum and placing it back inside the pelvic cavity, would be likely to result in contamination of the carcass has been a matter of debate. The Norwegian Scientific Committee for Food Safety recommends use of Method 1, with sealing of the rectum (Norwegian Scientific Committee for Food Safety, 2012).

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In their report they conclude that “there is a significant possibility of faecal contamination from the remaining bowel stump after the colon is severed, even if the operator is trying to “milk” contents away from the cut. Leakage from the bowel stump occurs very often” (Norwegian Scientific Committee for Food Safety, 2012). Support for this assertion is, however, not provided in the report, and to our knowledge, use of Method 1 (head down, rectum sealed) has not been documented to provide more hygienic sheep carcasses than use of Method 2 (head up, rectum cut).

The aim of our study was to compare the pelvic hygiene of sheep carcasses eviscerated using the two alternative evisceration methods applied under operational conditions.

2. Materials and methods

2.1. Abattoirs and slaughter lines

All Norwegian sheep abattoirs, except for the smallest, (i.e., those slaughtering fewer than 5000 sheep annually), were contacted and asked if they would be interested in participating in the study ($n = 21$). The abattoirs were categorized into four groups (A–D), according to the number of sheep slaughtered during the main slaughter season in 2013 (Table 1). These abattoirs represented 99.2% of the total number of sheep slaughtered in Norway during this period in 2013 (1.03 million). The sampling plan was designed in relation to the slaughter volume and the sampling was spread over a period of three to four weeks. Information about the abattoirs' methods of evisceration and decontamination was obtained through personal communication. The line speed generally depends upon abattoir size, and at the largest abattoirs the line speed can be up to 300 animals per hour.

2.2. Slaughter and evisceration methods

In Norway, sheep are shorn either prior to, or directly after, slaughter. Shearing on-farm is allowed under certain circumstances, a maximum of 3 days prior slaughter and when special clean housing and transport conditions are used.

All sheep carcasses are electrically stunned before bleeding, in which the blood vessels, oesophagus, and trachea are cut. All operators use the two-knives-method for hygienic slaughter (Hobbs, 1967; Peel & Simmons, 1978). Fleece removal starts with a mid-line cut through the fleece along the belly and brisket, and cuts along each front leg and throat (Y-cut), while the carcass is suspended by both forelegs and one or both hind legs. A few of the smallest abattoirs in the study performed this on sheep that were placed on their backs.

Different types of mechanical fleece pullers and rollers for skinning are used at the abattoirs at different stages of processing. At the last step of the fleece pulling, the carcasses are suspended by the forelegs.

In this study, abattoirs using Method 1 (head down, rectum sealed), rodding of the oesophagus was performed before evisceration (Hauge et al., 2015). In Method 1, the carcass was suspended by the hind legs or by all four legs, the rectum was sealed with a plastic bag (bagging) after circum-anal incision, and then the front part of the carcass was lowered such that it was only suspended by the hind legs. The bagged rectum was then pushed through the pelvic cavity (Fig. 1A) and removed, together with the intestines and the rodded rumen, through the

abdominal incision.

Abattoirs that suspend carcasses by the forelegs use the alternative evisceration method, Method 2 (head up, rectum cut). In this method, the oesophagus was cut by the diaphragm. The rectum was emptied of faecal content approximately 10–15 cm from the pelvis by stroking it in the oral direction, then the rectum was cut and placed back inside the pelvic cavity. The intestines and the rumen were removed through the abdominal incision. The carcass was then suspended by the hind legs also, and circum-anal incision was performed while the carcass was suspended by all four legs. The rectum was removed by pulling it backwards and out of the carcass, together with internal genitalia and the urinary bladder (Fig. 1B).

Some abattoirs use steam vacuuming on the outside of the carcass along the cut lines and pelvis, and some also use a steam vacuum on the inside of the pelvic cavity.

None of the abattoirs in the study washed or rinsed the carcasses with water during the whole slaughter process.

2.3. Carcass sampling

All sampling and analyses were conducted by the individual abattoir's quality management personnel after being provided with a detailed description (Supplementary material), which also included an instructional video of how to perform the sampling (Animalia - Norwegian Meat and Poultry Research Centre, 2014). The abattoirs collected samples according to the sampling plan showed in Table 1.

Written guidance on how the samples should be taken was worded as follows (translated here from Norwegian):

“It is important that different personnel conducting the sampling and analyses, perform as similarly to each other as possible and that standard equipment are used. Sampling must be done in weeks 38 to 44, 2014. Carcasses for sampling should be randomly selected in the chilling room 18 to 24 h post mortem. There should be a balance between sheep/rams/lambs, such that all categories are represented. Five swabs from the same sampling site (inside or outside the pelvic cavity) on five different carcasses should be pooled; that is, five swabs from five carcasses taken from equivalent sampling sites should be pooled to form one sample and should be placed together in one stomacher bag. One sample should be collected from inside the pelvic cavity and around the inside opening in an area of approximately 400 cm², and another sample should be taken on the outside in a circular area of approximately 100 cm² around the circum-anal incision.

Samples from inside and outside the pelvic cavity should not be pooled together.

To take the samples, sterile gauze cloths (Mesosoft 10 × 10 cm, Mölnlycke HealthCare, Gothenburg, Sweden) should be moistened with 10 ml sterile peptone water (Oxoid Ltd., Basingstoke, Hampshire, UK) and rubbed on the surfaces of the carcasses at the specified sites, with one sterile gauze cloth swab used on each sampling site. A sterile plastic bag should cover the arm of the operator during sampling and must be changed between each sampling site. The swab should be placed in the appropriate sterile stomacher bag after sampling.”

2.4. Microbiological analyses

The samples were analysed 0–20 h after swabbing, depending on

Table 1
Categorization of abattoirs and sampling plan.

Group	Number of animals slaughtered autumn 2013	Number of abattoirs	Number of weeks sampling	Sampling days per week	Samples per day	Carcasses per sample
A	> 90,000	5	4	3	5	5
B	50,000–90,000	5	4	2	5	5
C	20,000–50,000	4	4	1	5	5
D	5000–20,000	7	3	2	2	5

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