

INVESTIGATION ON LAMB MEAT PRODUCTION HYGIENE IN FACILITIES WITH LOW AND HIGH PRODUCTION CAPACITY

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Summary

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A comparative study on the microbiological parameters related to the hygiene status of two lamb slaughtering and processing facilities with low and high production capacity was performed. The data showed that the total viable count of microorganisms (TVC) varied between 4.09 and 6.79 log₁₀ cfu/cm² on small ruminant carcasses (SR) slaughtered at the smaller facility, while in the larger factory, the values varied between 4.32 and 7.20 log₁₀ cfu/cm². The values for Enterobacteriaceae varied within 1.30 to 3.18 log₁₀ CFU/cm² for the smaller factory and 1.27 to 6.05 log₁₀ cfu /cm² for the high capacity slaughterhouse. The results about the presence of *E. coli* were within the boundaries of 1 to 1.65 log₁₀ cfu /cm² for the small factory and 1.62 to 2.01 log₁₀ cfu /cm² for the facility with high capacity. The data about *E. coli* related to the different parts of a carcass showed a higher extent of contamination in the high capacity factory, with the exception of the outer surface of the chest, where the values were very close. The relationship between the strict application of good production and hygiene practices and results is discussed.

Key words: hygienic criteria, lamb meat, microbiological control

INTRODUCTION

The production of meat from small ruminants in the Republic of Bulgaria is regulated by the common rules and directives for food operators regarding the hygiene of foodstuffs of Regulation (EC) 852 based on food manufacturers' responsibility for food safety along the entire food chain, starting from basic production.

Commission Regulation (EU) 2073: 2005 and the amendments in Commission Regulation (EC) 1441:2007 specify the microbiological criteria for foodstuffs related to the presence of microorganisms, such as *Salmonella*, *E. coli*, representatives of the Enterobacteriaceae family, the total viable count of microorganisms, etc.

In Bulgaria, Poinarov (1980) has studied total viable count (TVC) of microorganisms, coliforms, staphylococci, salmonellae, enterococci, moulds and yeasts, reflecting the level of small animal meat production hygiene during the 1980-ties. Sheridan (1982) proved high values of TNM (log₁₀ 4.6–4.9 cfu/cm²) in small ruminant carcasses after washing. Washing the carcasses led to insignificant reduction of the overall microbial contamination. According to Mackey & Roberts (1993), a superficial microbial contamination above 10⁵/cm² proved that more attention is needed during the skinning process.

Factors, such as washing, treatment with solutions of antimicrobial preparations, treatment with hot water, etc. and their effect on the hygienic condition of small ruminant carcasses were summarized in the 6th edition of the International Commission on Microbiological Specifications for Foods (2000), as essential for good hygiene standards in meat production. Efficient sanitation of equipment and rooms at processing facilities is directly related to the hygiene status of the end product (Russev *et al.*, 2007; Todorov *et al.*, 2007).

The goal of the current study was to establish the dynamics of the basic microbiological indicators of the hygiene status at small ruminant slaughter facilities with low or high production capacity in different seasons.

MATERIALS AND METHODS

The collection of samples from the surface of processed small animal carcasses (lambs) was performed after dry and wet washing was completed and before their insertion into the freezing chamber. Samples were obtained from two small animal slaughterhouses – one with low production capacity (15–20 in average per day) and the second with a high production capacity (100–200 in average per day). The swab samples from 5 different areas on the carcass (outer surface of the thigh; outer surface of the chest bone; the middle of the neck; the middle part of the chest's outer surface; the internal most distal part of the chest cavity) were taken with sterile tampons Peptone water (buffered) Merckotube® (Merck).

Sampling was performed in compliance with the relevant rules determined by ISO 17604:2003 (Anonymous, 2003a). Samples were obtained once per season

from each facility (in June, September, December 2008, and March 2009), making for 120 swab samples from both slaughterhouses. They were immediately transported to the laboratory in a refrigerating container with a temperature of 0–4 °C. The samples were processed immediately after delivery. The total viable count (TVC) of microorganisms for each swab sample was determined, as well as the number of Enterobacteriaceae and *E. coli* in cfu/mL.

The swab sample preparation was performed in accordance with the requirements of ISO 6887 in order to prepare the necessary dilutions. The determination of TVC was done in accordance with BSS EN ISO 4833:2004 (Anonymous, 2003b).

The number of representatives of Enterobacteriaceae family in cfu/mL was established in accordance with ISO 21528-2:2004 (Anonymous, 2003b) and that of *E. coli* in cfu/mL – in compliance with ISO 16649-2 (Anonymous, 2001).

Results were log transformed and statistically processed by ANOVA using the Microsoft Excel software.

RESULTS

Fig. 1 shows the changes in the total viable count of microorganisms determined on the surface of lamb carcasses in the two slaughter facilities. The figure clearly indicates that TVC was high during the warm seasons (summer and autumn), especially in samples from the high-capacity slaughterhouse ($> 6 \log_{10}$ cfu/cm²). During the colder period of the year there were lower average TVC values (4.09 and 4.32 \log_{10} cfu/cm²) in the smaller and larger slaughterhouse, respectively. In the autumn, TVC was significantly lower ($P < 0.05$) at the smaller slaughterhouse, compared to TVC from the larger one.

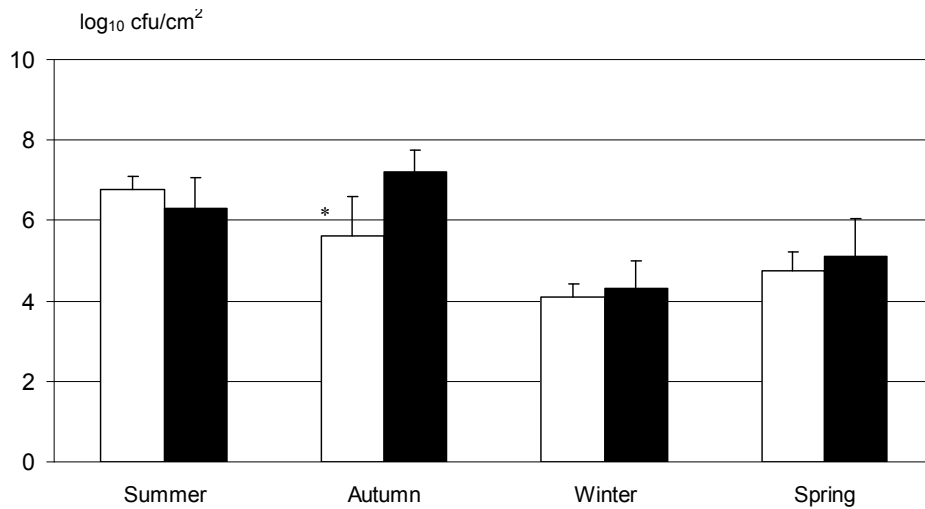


Fig. 1. Seasonal patterns of total viable count of microorganisms on the surface of lamb carcasses in a small (white bars) and large (black bars) slaughter facility. Data are presented as mean ± SD (n=15); * P<0.05.

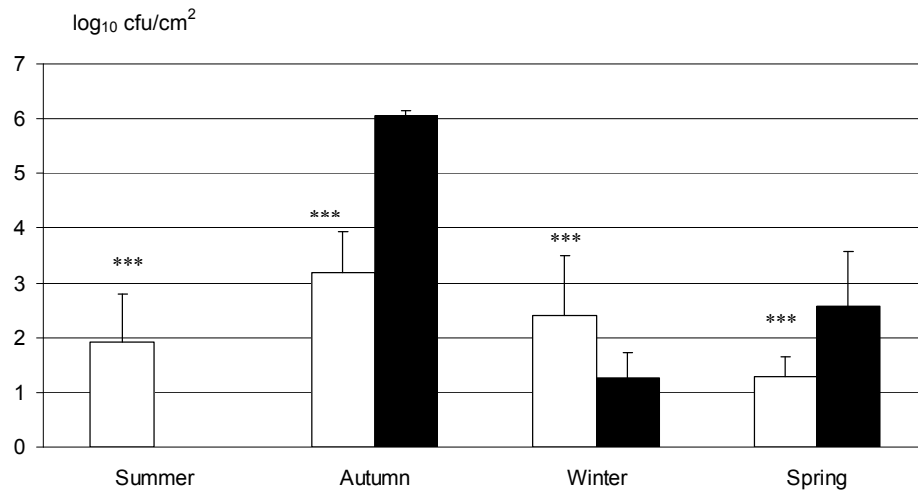


Fig. 2. Seasonal patterns of total viable count of Enterobacteriaceae on the surface of lamb carcasses in a small (white bars) and large (black bars) slaughter facility. Data are presented as mean ± SD (n=15); *** P<0.001.

The Enterobacteriaceae family microbial counts are presented on Fig. 2. The data show significant variations – in the smaller slaughterhouse the values varied

between 1.30 in the spring and 3.18 log₁₀ cfu/cm² in the winter. At the high-capacity slaughterhouse, the variation was greater – from 1.27 in the winter to 6.05 in the au-

tumn. The differences between the two facilities were significant for the autumn, winter, and spring ($P < 0.001$).

Fig. 3 illustrates the counts of *E. coli* on the surface of lamb carcasses from both facilities. The results indicated that

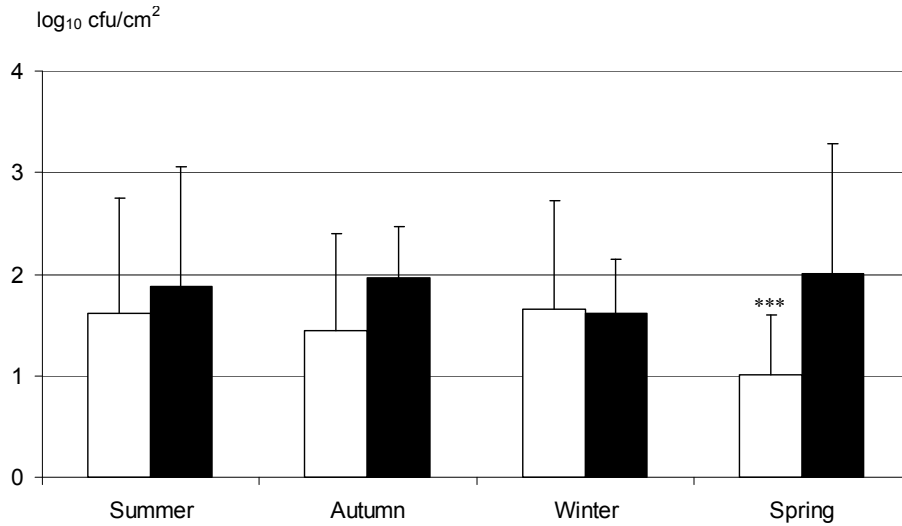


Fig. 3. Seasonal patterns of total viable counts of *E. coli* on the surface of lamb carcasses in a small (white bars) and large (black bars) slaughter facility. Data are presented as mean \pm SD ($n=15$); *** $P < 0.001$.

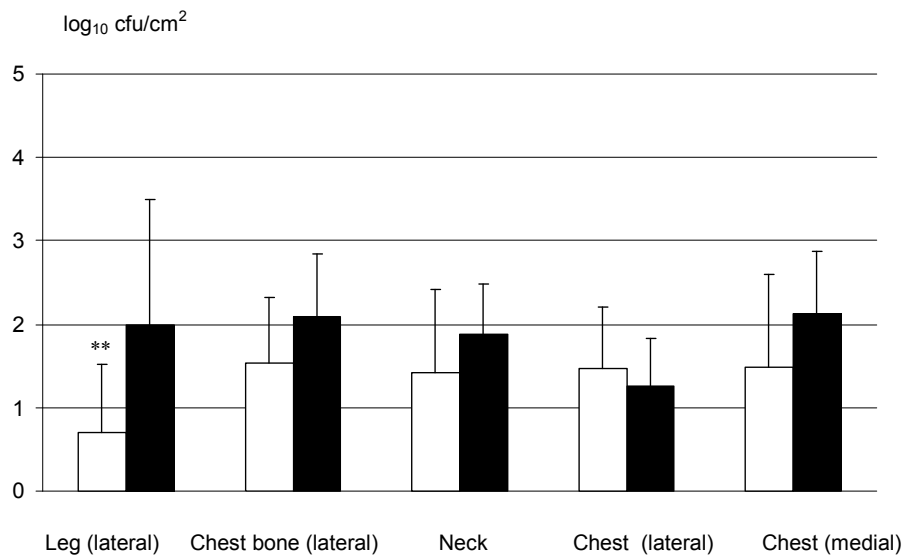


Fig. 4. Total viable counts of *E. coli* on different parts of lamb carcasses in a small (white bars) and large (black bars) slaughter facility. Data are presented as mean \pm SD ($n=12$); ** $P < 0.01$.

in samples from the smaller slaughterhouse they varies between 1.0 and 1.65 \log_{10} cfu/cm². Samples collected at the larger facility exhibited higher average values (near to 2.0 \log_{10} cfu/cm²). It should be noted that the results for the spring of 2009 (1.0 and 2.0 \log_{10} cfu/cm²) were statistically significant ($P < 0.001$).

E. coli counts varied also with regard to the site of obtained swabs (Fig. 4). Very low and statistically significant values ($P < 0.001$) could only be detected among the samples from the low-capacity facility, collected from the lateral leg surface (0.7 \log_{10} cfu/cm²). For all other locations, the results were similar and the differences – insignificant.

DISCUSSION

Summarizing the results for the criteria relevant to lamb slaughter and processing hygiene showed that they varied within rather wide ranges. According to Commission Regulation (EU) 2073:2005 microbiological criteria for small ruminant carcasses processed before chilling accept TVC values from 3.5 up to 5.0 \log_{10} cfu/cm², and for Enterobacteriaceae – from 1.5 to 2.5 \log_{10} cfu/cm². The data from this study showed that the average TVC for the high-capacity slaughter facility were above the maximum acceptable levels as per Regulation (EU) 2073, in three out of the four samples. At the smaller facility, the levels were higher than the acceptable in the first two sample-takings, and afterwards they were within the required range.

Regarding the second criterion (Enterobacteriaceae), samples taken from the larger slaughterhouse exceeded the acceptable counts of 2.5 \log_{10} cfu/cm² in two out of three instances. The samples from the smaller slaughterhouse, in three out of

four samplings, had values within the allowed range, in accordance with Commission Regulation (EC) 2073:2005. The data of Poynarov (1980) on the hygiene status of lamb carcasses processed before chilling showed the highest extent of contamination on the leg and the external rib area, and lowest on the neck, chest internal surface, and the shoulder.

Our research showed that the hygiene status of the leg was the best, especially at the low-capacity production facility. In samples taken from small ruminant carcasses in Australia, Grau (1979) established TVC of 3.18 \log_{10} cfu/cm² and *E. coli* counts 0.99 \log_{10} cfu/cm². In England Roberts *et al.* (1980) established TVC within the range of 2.54 to 3.25 \log_{10} cfu/cm², in Ireland Kelly *et al.* (1980) determined mean TVC of about 3.77 \log_{10} cfu/cm², with these values proving better hygiene status than the one observed in our studies. For small ruminants in Spain, Prieto *et al.* (1991) determined a mean TVC value of 4.96 \log_{10} cfu/cm², whereas in India Bhandarea *et al.* (2007) established 5.13 \log_{10} cfu/cm², which is very close or above the maximum allowed levels by Regulation (EU) 2073:2005. Rao & Ramesh (1992) proved that the extent of contamination was not related to the seasons and found higher contamination on the ventral area (shoulder and neck) of the carcass, with TVC in 86.6% of the examined carcasses within the range of 3.0–4.9 \log_{10} cfu/cm². The data were close to what was observed in our study, regarding the topography of swab samples.

Our studies indicated that the season had an influence on the results, with the lowest extent of contamination being detected in the winter for both facilities. Following a nation-wide monitoring programme in Australia, Phillips *et al.* (2006) determined that the mean TVC values

were 2.28 log₁₀ cfu/cm², with *E. coli* presence in only 43% of the examined small ruminant carcasses at a contamination rate of log₁₀ 0.03 cfu/cm². Sumner *et al.* (2003) performed a hygiene status study on larger and smaller small ruminant slaughterhouses in Australia and established a mean TVC value of 2.59 log₁₀ cfu/cm², with *E. coli* contamination on 36.2% of carcasses and a low mean value of contamination (log₁₀ 0.27 cfu/cm²). Mean TVC values determined in larger and smaller slaughterhouses were 2.80 and 2.44 log₁₀ cfu/cm² respectively, with variations in smaller facilities ranging between 1.63 and 3.65 log₁₀ cfu/cm². In larger facilities, 61.5% of carcasses were contaminated with *E. coli*, while in the smaller – 18.5%.

Comparing our results to those from similar studies performed in countries with working good hygiene practices (GHP) and developing countries in the process of introducing GHP showed that the hygiene status of produced lamb meat was closer to the standard of developing countries. Of particular concern is the fact that the results from the high-capacity slaughter facility showed higher levels of contamination, compared to a smaller one. The samples from both facilities were collected from carcasses from the midst of the respective batch of animals in order to obtain as objective data as possible on the slaughtering hygiene and the functioning of GHP in the respective facility, respectively.

In conclusion, the introduction, maintenance and functioning of GHP (a self-control system) is not just a formal act but an active system facilitating the production of quality and safe meat from small ruminants. The current results indicate that the self-control system in the examined facilities does not guarantee com-

pletely the fulfillment of the hygiene requirements included in Commission Regulation (EU) 2073:2005.

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