# Microbiological status of pork and beef carcasses at abattoirs

## Mikrobiologiczny status tusz wieprzowych i wołowych w rzeźniach

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**Wprowadzenie.** Ubój zwierząt rzeźnych niesie ze sobą ryzyko poważnych problemów zdrowia publicznego wskutek skażenia mikrobiologicznego mięsa. Dlatego też bardzo ważny jest monitoring stanu mikrobiologicznego tusz po uboju.

**Cel.** Niezależna ocena stanu higienicznego surowca mięsnego w kontekście potencjalnych zagrożeń mikrobiologicznych towarzyszących pozyskiwaniu tusz wieprzowych i wołowych w rzeźniach zlokalizowanych w typowym regionie rolniczym.

**Materiały i metody.** W okresie dwudziestu miesięcy przebadano 335 tusz wieprzowych i 200 tusz wołowych z różnych rzeźni na terenie w północno-wschodniej Polski w kierunku ogólnej liczby bakterii tlenowych (TAB) oraz Enterobacteriacea (ENT). Ponadto 305 wieprzowych i 167 tusz wołowych badano na obecność bakterii Salmonella. Badania wykonano według regulacji EU i norm międzynarodowych (ISO).

**Wyniki.** TAB i ENT wykryto na tuszach obu gatunków, natomiast Salmonelli nie stwierdzono na żadnej badanej próbie. Wszystkie próbki tusz zawierały TAB, zaś ENT wykryto na większości (>90%) tusz wieprzowych i 100% wołowych. Ponad 50% tusz wieprzowych zawierało <10 CFU/cm$^2$ TAB, a w 25,7% tusz wahała się 100-1000 CFU/cm$^2$. 84% spośród tusz wołowych zawierało <10 CFU/cm$^2$ TAB. Tusze wieprzowe w porównaniu do wołowych posiadały istotnie więcej TAB ($p<0,01$), nie stwierdzono istotnych różnic w liczebności ENT.

**Wnioski.** Badane próby mięsa spełniały europejskie kryteria higieniczne. Z uwagi na potencjalne zagrożenia, monitorowanie stanu mikrobiologicznego mięsa jest konieczne, zwłaszcza w przypadku linii ubojowych świń.

**Słowa kluczowe:** *higiena, rzeźnie, tusze wieprzowe i wołowe, zagrożenie mikrobiologiczne*

**Introduction.** The slaughtering of livestock always poses a risk of serious public health problems due to contamination of meat by microorganisms, and for this reason the monitoring of the microbiological status of carcasses following slaughter is very important.

**Aim.** Independent evaluation of the hygienic condition of raw meat in terms of the potential microbiological hazards associated with processing pork and beef carcasses in abattoirs located in a typical agricultural region.

**Materials & methods.** Over a period of twenty months a total 335 pork and 200 beef carcasses from several abattoirs in north-eastern Poland were examined with regard to total numbers of aerobic bacteria (TAB) and Enterobacteriaceae (ENT). In addition, 305 pork and 167 beef carcasses were examined for the presence of Salmonella. The tests were performed in accordance with EC regulations and international standards (ISO).

**Results.** TAB and ENT were detected in both types of carcass; however Salmonella was not detected in any of the tested samples. All carcasses tested positive for TAB, and ENT bacteria was detected in most of the pork (>90%) and 100% of the beef carcasses. Over 50% of the pork carcasses contained <10 CFU/cm$^2$ of TAB, and in 25.7% the result ranged between 100-1000 CFU/cm$^2$. TAB in the range <10 CFU/cm$^2$ were detected in 84% of the beef carcasses. Compared to beef, the pork carcasses harboured significantly ($p<0.01$) higher numbers for CFU/cm$^2$ of TAB, but in terms of ENT figures there were no significant differences between beef and pork carcasses.

**Conclusions.** The meat samples tested met the European hygiene criteria. Due to the potential hazards, monitoring of the microbiological status of meat is necessary, especially in the case of pig slaughtering lines.

**Key words:** *hygiene, abattoirs, pork and beef carcasses, microbiological hazard*

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## Introduction

Around the world, meat and meat products constitute important foodstuffs, but food borne diseases caused by bacterial contamination of meat products frequently constitute a serious public health concern [1]. For this reason, it is essential that the microbiological status of carcasses is monitored during slaughter and meat processing, as well as in the storage of meat products in order to prevent the spread of food borne diseases among consumers. The slaughtering process always carries a risk of carcass contamination by the microflora present in the gastrointestinal tract, and despite the strict measures taken to reduce the risk of cross-contamination, there remains a real and present danger of bacteria being transferred to carcasses. In the European Union, Regulation EC 2073/2005 on microbiological criteria for foodstuffs has led to monitoring of Total Aerobic Bacteria (TAB), *Enterobacteriaceae* (ENT) and *Salmonella* counts as the indicator of process hygiene criteria for beef and pork carcasses [2].

Where the hygienic quality of pork and beef carcasses is poor, public health is put at risk, and thus monitoring of bacteria is an important measure to ensure food safety. Proper handling of meat may minimize the amount of bacteria present on carcasses. Effective sanitary procedures include trimming, steam vacuuming, carcass washing, and hot water rinses, organic acid rinses and steam pasteurization [3].

Routine monitoring of carcasses and meat products involves testing for aerobic bacteria, intestinal bacilli, and *Salmonella* spp. [4]. European Union countries, including Poland, are significant trading partners in the global pork and beef market. Much of the meat production originates in small and medium sized local processing facilities. However, there is little official information available regarding meat hygiene in such establishments processing beef and pork in EU countries, including Poland.

## Aim

Independent evaluation of the hygienic condition of raw meat in terms of the potential microbiological hazards associated with processing pork and beef carcasses in abattoirs located in a typical agricultural region.

## Materials and methods

Samples were collected from several abattoirs in north-eastern Poland over a period of twenty months. Sampling was performed after carcasses had been dressed, within 3 hours of their being chilled. Sampling by excision is commonly considered the preferred method for recovery of bacteria from beef and pork carcasses [4, 5]. Accordingly, this approach to sampling was chosen for the present study. The samples were collected in accordance with the PN-ISO 17604:2005 [6] directives using sterile techniques, and immediately transferred to the laboratory for further microbiological analyses. The sampling method and the locations for testing of carcasses were in accordance with the directives of the EU Commission's 2001 Decision (2001/471/EC) [7]. The following sites were used in the sampling of beef carcasses: neck, brisket, flank and rump, while the pork carcass samples were taken from: the back, the jowl, the medial aspect of the ham (*Vastus medialis*) and the belly.

A total of 335 pork carcasses and 200 beef carcasses were examined to estimate total aerobic bacteria (TAB) and intestinal bacilli from the *Enterobacteriaceae* family (ENT). Additionally, 305 pork carcass samples and 167 beef carcass samples were tested for the presence of *Salmonella* species.

The above mentioned bacteria groups were analyzed according to the standardized methods: ISO 4833:2003 [8], ISO 4833:2004/Ap.1/2005 [9] and ISO 6579:2003 [10]) as described by Kwiatek, et al. [11].

Representative meat samples from each carcass were placed in a sterile stomacher bag containing 200 ml of buffered peptone water, and homogenized using a stomacher (Waring, 32BL80, New Hartford, USA) at 1500 G for 2 minutes.

Material from the first homogenate was transferred to another sterile bag and stomached again with the addition of 200 ml of peptone water (a 10-1 dilution), followed by tenfold serial dilutions in 0.1% sterile peptone water.

The spread-plate technique was used, with a 100 µl of serial dilution placed on duplicate plates to assess the numbers of bacteria in each sample. The numbers of aerobic bacteria were determined by the Standard Plate Count Agar APHA method (Oxoid, CM 463) following incubation at 35°C for 48 hours. After incubation, all colonies found on the plates were counted. Samples for *Enterobacteriaceae* counts were placed on plates of violet red bile glucose agar (Oxoid, CM 485) and incubated at 37°C for 24 hours, and following incubation, all purple colonies were counted. In order to test samples for the presence of *Salmonella* species, samples from the first homogenate were transferred to a sterile Erlenmeyer flask with 200 ml of buffered peptone water (Oxoid, CM 509) and incubated at 37°C for 24 hours. Following this, 1 ml of the culture obtained was transferred to a second enrichment broth (selenite cystine broth Oxoid, CM 699) with sodium bi-selenite and a Rappaport Vassiliadis enrichment broth (Oxoid, CM 669). After a 24 hour incubation period at 37°C, a combination of bismuth sulphite agar (Oxoid, CM 201), modified brilliant green agar (Oxoid, CM 329) and hectoen enteric agar (Oxoid, CM 419) was used for selective plate incubation. Presumed *Salmonella* colonies from each of the selective media plates were further confirmed using the API 20E identification system as described by its manufacturer (BioMerieux, Basingstoke, UK).

Microbial counting, isolation and identification of microorganisms were performed according to the criteria of EU Regulations and Specific Standards (EC) No. 1441/2007 [12] and 2073/2005 [1] for meat. The results were compiled in accordance with microbiological criteria, presented as colony forming units per $cm^2$ ($CFU/cm^2$). For statistical analysis purposes, the TAB and ENT bacteria data was $Log_{10}$ converted using the T-Test [13].

## Results

In the presented study, total aerobic bacteria (TAB) and *Enterobacteriaceae* (ENT) were found in both pork and beef carcasses, however *Salmonella* was not detected in any of the samples examined. All beef

and pork carcass samples tested positive for TAB. ENT bacteria were recovered from the majority of the 335 (95.5%) pork carcass samples and from all 200 of the beef carcasses.

TAB results (CFU/cm$^2$) ranged from 1 to 652 (pork) and from 1 to 630 (beef). However, ENT results ranged from 1 to 543 for pork and from 1 to 4 (CFU/cm$^2$) for beef carcasses respectively. In pork carcasses, the geometric mean for CFU per cm$^2$ of TAB was considerably higher than in beef carcasses, while the geometric mean for CFU of ENT was similar in both types of carcasses.

In pork carcasses, 60.0% (201) contained <10 CFU/cm$^2$ of TAB, and in 25.7% (86) carcasses, TAB ranged from 100-1000 CFU/cm$^2$. The remaining 48 pork carcasses (14.3%) contained these bacteria in the range from 10 to 100 CFU/cm$^2$. In 168 (84.0%) of the beef carcasses, TAB were found in the range <10 CFU/cm$^2$. There were 15 beef carcasses (7.5%) containing TAB in the range of 10 to 100 CFU/cm$^2$, and 17 samples (8.5%) in the range >100 CFU/cm$^2$.

In the pork carcasses, 15 (4.5%) tested negative for ENT, however in 315 (94.0%) ENT were found in the range <10 CFU/ cm$^2$. Only 3 out of all tested pork samples (0.9%) were found to be contaminated with ENT in the range 10 to 100 CFU/ cm$^2$, and only 2 samples (0.6%) showed a value above 100 CFU/ cm$^2$. A total 1.5% of pork samples showed bacteria belonging to ENT in excess of 0.7 $\log_{10}$ CFU/cm$^2$. All 200 (100.0%) tested beef carcasses showed <10 CFU/cm$^2$ of ENT and many did not exceed 0.7 $\log_{10}$ CFU/cm$^2$.

It was notable that compared to beef, pork carcasses harboured larger numbers of aerobic bacteria (TAB), with the mean $\log_{10}$ CFU/cm$^2$ of TAB counts being significantly ($p<0.01$) higher for pork carcasses (1.28 *vs.* 0.73). There were no significant differences between beef and pork carcasses in terms of *Enterobacteriaceae* (ENT) counts (0.39 *vs.* 0.39).

## Discussion

Pathogens such as *Salmonella* species and certain bacteria belonging to the *Enterobacteriaceae* family, particularly *E. coli* O157:H7 are considered the most serious food safety hazards associated with the consumption of meat and meat products [1].

Our findings are generally in line with the observations of Petruzzelli, et al. [14], who reported that compared with pork, beef carcasses showed significantly lower mean log counts for both TAB and ENT. Our findings are also consistent with those reported by Rahkio and Korkeala [15] and Bohaychuk, et al. [16]. However, the mean log counts of aerobic bacteria in our study were considerably lower than those reported in Swiss, Swedish, and Romanian studies [17-21]. The counts of *Enterobacteriaceae* detected in the samples tested in our study are comparable to the levels reported by Zweifel, et al. [18].

In our study, no *Salmonella* species were detected in pork or beef, which is consistent with the results of other Polish studies [22]. In contrast, Botteldoorn, et al. [23] reported that *Salmonella* was isolated from 37% of the pork carcass samples from Belgian abattoirs, located in western Belgium, an area of high density pig production. Also Meyer, et al. [24] found small amounts of *Salmonella* in both pork and beef carcasses from slaughterhouses located in Southern Germany.

Overall, the absence of *Salmonella* and the only very low counts of *Enterobacteriaceae* in the examined carcasses indicate that the risk of contamination with pathogens significantly hazardous to human health, such as *Salmonella* or *E. coli* is very low, if any. Generally, taking all the tested samples in account, the status of carcasses examined in the present study met the limit standards for microbiological counts in foodstuff of animal origin [12].

## Conclusion

The study conducted provides independent information for consumers, and contributes to the database for further evaluation of trends in microbiological risk factors in pork and beef carcasses. The meat samples examined in our study fully conform to EU rules concerning hygienic criteria for foodstuff of animal origin. The results presented here reflect good processing conditions in terms of the slaughtering and handling of carcasses, and provide general evidence of satisfactory hygienic practices in the abattoirs studied. Nevertheless, the present study revealed that a risk of bacterial contamination of pork and beef carcasses, albeit negligible, does exist. Periodical monitoring may help identify critical factors, and result in recommendations for improving meat processing hygiene, particularly in pig slaughtering procedures.

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