PRESENCE OF SELECTED MICROORGANISMS ON MEAT CONTACT SURFACES IN THE MEAT CUTTING FACILITY

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Abstract

The deep muscle tissue of healthy, slaughtered livestock does not contain any, or contain few microorganisms. However, their exterior surfaces (hide, hair, skin, and feathers) and gastrointestinal tracts are naturally contaminated with a variety of microorganisms. From the moment of slaughter, each processing step exhibits the carcass to opportunities for contamination with microorganisms from the exterior surfaces, utensils and equipment and, most importantly, from the gastrointestinal tract. Cutting of carcasses also involves the use of utensils and equipment transfers microorganisms to the cut surfaces. There is opportunity to contaminate the exposed tissues of the carcass with microorganisms from: exterior surface of the animal, the contents of the gastrointestinal tract, equipment and utensils, worker garments and hands, the slaughterhouse itself (e.g. air, floor drains, water drip from the ceiling), water (and if used, ice), food additives (e.g. spices for value added products).

The aim of this study was to determine the presence of selected microorganisms (total aerobic mesophilic bacteria, total number of Enterobacteriaceae, presence of Listeria monocytogenes) on meat contact surfaces in the cutting meat facility. The study included 50 samples that were taken from ten meat contact surfaces to a cutting plant. The swabs are tested for five working days, for a period of two weeks. All microbiological examination were conduct according to ISO methods.

For most of the swab samples that do not correspond to the recommended microbiological criteria increased number of aerobic mesophilic bacteria and total Enterobacteriaceae was established. L. monocytogenes was not found in the tested surfaces in the cutting meat facility.

Considering the great role of education in the improvement of practice at slaughter houses, training for all employees on hygiene in establishments producing meat is recommended.

Key words: Hygiene, Contamination, Microorganisms, Meat cutting, L. monocytogenes.

1. Introduction

Food industry makes efforts to remove all those factors which contribute to the occurrence of poisoning in order to control foodborne pathogens and advance consumers health. Experts have tried to eliminate biological contamination of food in the process of production by using effective and, for the consumers, safe actions of decontamination due preventive hygienic-sanitary measures and technological innovations [1, and 2]. Preventive measures include systematic, effective and continuous work on realization of sanitary and hygienic principles of food production from “farm to fork” [3]. In order to achieve these goals, certain concepts are suggested, such as HACCP (Hazard Analysis & Critical Control Point), Good Manufacture Practice (GMP) and others [4]. A precondition for their application is effective routine diagnosis, which present the reason why experts work on the introduction of more modern actions into the practice which aside from quick fitting of the results, make sure that they are correct. In the course of slaughtering animals, meat can be contaminated by bacteria from the carcass surfaces and becomes a health hazard. A number of factors such as species, age, background, breeding, nutriment, transport, manipulation, hygiene of slaughtering, treatment and distribution affect meat contamination [5].

Aside from meat inspection, it is also necessary to monitor all the factors which present a risk of contamination in all phases of the process in the slaughtering
section. Since meat can be primarily contaminated, from various sources, WHO (World Health Organization) through their committee International Commission on Microbiological Specifications for Foods (ICMSF) (1982 - 1988) recommend [6], as the most effective way of control, HACCP (Hazard Analysis & Critical Control Points) system - the analysis of risk by controlling critical points. The key element of HACCP system is usage of quick methods for monitoring control at all critical points. Microbiological status of meat and meat products should be established for determination of meat quality and suitability for further treatment and consumption. It is necessary to apply suitable acts of inspection, which will provide the most accurate presentation of the circumstances in a short period of time in order to obtain the necessary data for determination of microbiological quality of raw materials and products. When using standard procedures, the results are obtained fairly late, or when they practically cannot be used anymore [7]. This is the reason why the experts have lately been working on the introduction of more modern actions into practice, which will make sure that the gained results are correct.

The surfaces from which samples are taken, the sampling frequency, eligibility and possible corrective measures and all the information that are available about the potential hazards have to be taken in account in order to keep them under control. In special cases determination of L. monocytogenes presence as a specific bacterium which is major threat to human health [8 - 11] on the working surfaces is a must.

The aim of this study was to examine the level of surface contamination by microorganisms (total aerobic mesophilic bacteria number, total number of enterobacteria, presence of L. monocytogenes) which are coming into contact with meat during meat cutting, after disinfection.

2. Materials and Methods

The study was conducted by taking swabs from the following areas: 1 - table for cutting pork, 2 - table for deboning process, 3 - table for slice off skin, 4 - table for the French meat processing, 5 - table for cutting beef meat, 6 - cleavers, 7 - carts to transport meat I, 8 - carts to transport meat II, 9 - scales I, 10 - scales II. Swabs from all surfaces were taken according to “Guide for the application of microbiological Criteria Row for food”[12]. Swabs were individually packaged in sterile tubes.

Surface samples were taken from meat contact surfaces made from stainless steel or plastic. Defined surfaces were swabbed with cotton swabs wetted in 1% peptone water (Buffered Water peptone - BPW, Oxoid). Surfaces were sampled using a sterile template with hollow internal area of 100 cm² (10 cm x 10 cm). The swabs were transferred into a tube with 10 mL of sterile 1% peptone water (Buffered Water peptone - BPW, Oxoid). Swabs were transported to the laboratory at a temperature from 1 °C to 4 °C.

2.1 Microbiological analysis

Following microbiological analysis and methods were employed:


2.2 Statistical analyses

Statistical analysis of the results was performed using software GraphPad Prism 5.00 (Version 5.00 for Windows, Graph Pad Software, San Diego California USA - www.graphpad.com). All parameters were represented by descriptive statistical parameters (mean, standard deviation). One-factor analysis of variance-ANOVA and post Tukey test were used for testing differences among average total bacterial number and total number of enterobacteria on examined surfaces. Chi-square test was used to compare frequencies among unsatisfactory and satisfactory total bacterial number.

3. Results and Discussion

Food hygiene is applied through appropriate sanitation and maintenance of hygiene of worker hands and tools, equipment, and correct technological operations [13, 14]. The control of conducting so-called good hygienic practice should provide for the created technical-technological conditions a positive result, or more precisely hygienically acceptable meat [15]. Microbiological examination is only an objective confirmation for the efficacy of that control. Since standard methods are not suitable for a routine check-up when there are a large number of samples, various methods have been developed with the goal to define the microbiological status of meat and meat products more quickly [16, 17]. Quick methods should be more and more applied in industrial production of food products, especially when talking about HACCP implementation, which itself requires quick observation of all possible hazards, in this case microbiological, so that we can react on time if any unwanted situation occur [18, 19].

3.1 The total bacteria number of the work surfaces in the meat cutting facility

The total bacteria number in pork determines its hygienic status and is usually one of the quality parameters.
that determine the viability of meat [20]. On the hygienic status of meat, facility engaged in its production has a major impact. In the first week of testing (Table 1) the average total bacteria number of the ten examined working surface was about $1.87 \pm 0.27 \log \text{CFU/cm}^2$ (fifth day) to $2.93 \pm 0.43 \log \text{CFU/cm}^2$ (first day). The average total bacteria number on the first day of the survey was significantly higher ($p < 0.01$) than the total bacteria number of the fifth day of testing. In the second week of investigation, the average total bacterial number of the ten examined workspaces was from $2.07 \pm 0.19 \log \text{CFU/cm}^2$ (the first day of testing) to $2.39 \pm 0.69 \log \text{CFU/cm}^2$ (the fifth day of the study). There were no statistical differences between average values of total bacterial count during five days of testing (Table 1).

The incidence of unsatisfactory total bacterial number was from 80% (the fourth day) to 100% (the first day). The unsatisfactory total bacterial number was significantly higher ($p < 0.01$) than satisfactory total bacteria number on the examined surfaces of all days during the first week of the survey. During the second week of testing, frequency of unsatisfactory total bacterial numbers was from 90% (second day) to 100% (all other days). All the days of testing during the second week unsatisfactory total bacterial number was significantly higher ($p < 0.01$) than satisfactory total bacteria number on the examined surfaces (Table 2).

The frequency of unsatisfactory total bacterial number (%) was significantly higher ($p < 0.01$) than the frequency of satisfactory total bacterial number, during all days of the two weeks study. The first week of study total bacterial number of samples taken from the work surface in the facility for cutting meat was less than the recommended microbiological criteria only in three samples (6%) (Figure 1). For the second week of the survey, that number was even lower (one sample or 2%). During the first and second week of study in two samples (4%) total bacterial number was under the recommended microbiological criteria.

The total mesophilic bacterial number in meat and meat products is one of the most useful indicators of their microbiological status [21]. A large number of living microorganisms often shows: that the raw material was contaminated, that the hygiene during treatment was unsatisfactory, that the temperature during production or storing was unsatisfactory or that a combination of these or other factors occurred. A large number of living microorganisms also indicate the possibility that meat can quickly become rotten, so, the total mesophilic bacterial number can be observed as the indicator of hygienic state, even though it is not reliable enough [5]. Counting of aerobic mesophilic bacteria can be done, for example, to determine how long some product can be preserved in the refrigerator container or some other warehouse.

Table 1. The average total bacteria number (log CFU/cm²) on the examined surfaces (n = 50)

<table>
<thead>
<tr>
<th>Weeks of testing</th>
<th>Day of storage ($\bar{X} \pm Sd$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>First week</td>
<td>$2.93 \pm 0.43$</td>
</tr>
<tr>
<td>Second week</td>
<td>$2.07 \pm 0.19$</td>
</tr>
</tbody>
</table>

*Legend:
$^a$ = significant differences $p < 0.05$

Table 2. The frequency of unsatisfactory and satisfactory total bacterial number (%) on the examined surfaces (n = 50)

<table>
<thead>
<tr>
<th>Total bacterial number (%)</th>
<th>First week (Days of testing)</th>
<th>Second week (Days of testing)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Unsatisfactory number</td>
<td>$100^a$</td>
<td>$90^a$</td>
</tr>
<tr>
<td>Satisfactory number</td>
<td>$0^a$</td>
<td>$10^a$</td>
</tr>
</tbody>
</table>

Legend:
$^a$ = significant differences $p < 0.01$
According to the Guidelines for the application of microbiological criteria for foods in 2011 on porcelain, glass and smooth metal surfaces (scales, wheelchair transportation, the cleavers) the total bacterial number must not be greater than 10 log CFU/cm², and in other areas (plastic surface for cutting meat) the total mesophilic bacterial number must not be greater than 30 log CFU/cm² [12]. Our results show that in all tested areas total mesophilic bacterial number was above the prescribed value (Table 3).

3.2 Total number of Enterobacteriaceae on work surfaces in the meat cutting facility

The presence of Enterobacteriaceae on surfaces that come into contact with meat is examined in order to assess the general meat hygienic status. Some strains of Enterobacteriaceae are of interest for public health, while others have commercial importance because of their ability to cause meat and meat products defects during the storage at refrigerator temperature [22].

Standards or instructions of individual countries are defined as levels of surface contamination by microorganisms. Thus, in Sweden, an acceptable level of contamination is if there are detected fewer bacteria than 1 CFU/cm²; if the level of contamination between 1 CFU/cm² and 3 CFU/cm² the result is considered as acceptable, but as a warning to cleaning and disinfection must be improved [12]. If number of microorganisms is greater than 3 CFU/cm², results are considered as not acceptable and this indicates that a surface is not clean. In addition to the total number of bacteria for the control of the production hygiene conditions the number of Enterobacteriaceae should be used. According to EU recommendations, the total bacterial number in the contact area is considered acceptable if this number is between 0 log CFU/cm² and 10 log CFU/cm², and the number of Enterobacteriaceae is from 0 log CFU/cm² to 1 log CFU/cm².

During the first week, the total number of Enterobacteriaceae at the first day (3.08 ± 0.63 log CFU/cm²) was significantly higher (p < 0.01; p < 0.05) than the total number of Enterobacteriaceae at the second (1.97 ± 0.81 log CFU/cm²) and the fifth day of testing (1.24 ± 0.30 log CFU/cm²). Gained results are shown in Table 4.

### Table 3. The total bacterial number (log CFU/cm²) on the examined surfaces (n = 50)

<table>
<thead>
<tr>
<th>Surface</th>
<th>First week (Days of testing)</th>
<th>Second week (Days of testing)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>1</td>
<td>2.85</td>
<td>3.31</td>
</tr>
<tr>
<td>2</td>
<td>3.13</td>
<td>3.38</td>
</tr>
<tr>
<td>3</td>
<td>1.75</td>
<td>4.31</td>
</tr>
<tr>
<td>4</td>
<td>3.11</td>
<td>3.38</td>
</tr>
<tr>
<td>5</td>
<td>3.15</td>
<td>1.93</td>
</tr>
<tr>
<td>6</td>
<td>3.31</td>
<td>0.91</td>
</tr>
<tr>
<td>7</td>
<td>3.02</td>
<td>1.95</td>
</tr>
<tr>
<td>8</td>
<td>2.95</td>
<td>1.61</td>
</tr>
<tr>
<td>9</td>
<td>3.08</td>
<td>1.61</td>
</tr>
<tr>
<td>10</td>
<td>2.99</td>
<td>1.51</td>
</tr>
</tbody>
</table>

Legend:
- Swabs from: 1 - table for cutting pork, 2 - table for deboning process, 3 - table for slice off skin, 4 - table for the French meat processing, 5 - table for cutting beef meat, 6 - cleavers, 7 - carts to transport meat I, 8 - carts to transport meat II, 9 - scales I, 10 - scales II.

### Table 4. The average total number of Enterobacteriaceae (log CFU/cm²) on examined surfaces (n = 50)

<table>
<thead>
<tr>
<th>Weeks of testing</th>
<th>Days of testing (X ± Sd)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>First week</td>
<td>3.08 ± 0.63</td>
</tr>
<tr>
<td>Second week</td>
<td>1.33 ± 0.21</td>
</tr>
</tbody>
</table>

Legend:
- **A** = significant differences p < 0.01.
- * = significant differences p < 0.05.
Differences between unsatisfactory and a satisfactory number of Enterobacteriaceae compared between testing days of the first and the second week are shown in Table 5. On the first day of the first week of testing the incidence of an unsatisfactory number (100%) of Enterobacteriaceae was significantly higher (p < 0.01) than the satisfactory number (0%) of Enterobacteriaceae on the working surfaces in the cutting meat facility. On the fourth day of the second week of testing the unsatisfactory number (20%) was significantly lower (p < 0.01) than satisfactory number of Enterobacteriaceae (80%) on the working surfaces in the cutting meat facility.

During the first week of testing, only in 30% (15 samples) of samples the total number of Enterobacteriaceae was satisfactory, during the second week, 58% (29 samples) and including both weeks of the study this number was 44% (44 samples) (Figure 2).

Table 5. The frequency of unsatisfactory and satisfactory number of Enterobacteriaceae (%) on the working surfaces (n = 50)

<table>
<thead>
<tr>
<th>Number of Enterobacteriaceae (%)</th>
<th>First week (days of testing)</th>
<th>Second week (days of testing)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Unsatisfactory number</td>
<td>100</td>
<td>70</td>
</tr>
<tr>
<td>Satisfactory number</td>
<td>0</td>
<td>30</td>
</tr>
</tbody>
</table>

Legend: Same letters * significant differences p < 0.01

3.3 Presence of L. monocytogenes on working surfaces in the meat cutting facility

The presence of L. monocytogenes was not detected during the testing of all swabs samples in the cutting meat facility. However, it should be noted that the survival and growth of L. monocytogenes in the food, including the meat, depends on the conditions of producing, packaging and storing, and the food characteristics in the literature described as internal (composition and physical-chemical properties) and external, i.e. environmental factors (humidity, temperature, and gas concentrations) [12].

It is usual to check hygiene focus on easily available working surfaces, or those areas that are most frequently in contact with food [23]. Frequently the assessment of surfaces hygienic status are based on the number of Enterobacteriaceae and aerobic colony per cm² [24]. Particular interest in working surfaces hygiene assessment is finding pathogens, such as the presence of L. monocytogenes on surfaces, which are in contact with food that after processing. Absence of L. monocytogenes indicates that the process of cleaning and disinfecting were done correctly.

4. Conclusions

- In this survey, the average total bacterial number of the tested surfaces which are in contact with meat were the highest during the first week and the lowest on the fifth day.
- In the second week of the experiment, the average total number of bacteria was the same during all five days.
- There were statistical differences between unsatisfactory and satisfactory total bacterial number on surfaces which come in contact with food, during all days of testing.
- Considering the great role of education in the improvement of practice at slaughter houses, training for all employees on hygiene in establishments producing meat is recommended.

Acknowledgement

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5. References


