Abstract. This paper presents an investigation of the microbiological quality of duck meat sold on the Polish market. To our knowledge, this is the first report focusing on the duck meat microflora. Bacteriological analysis was performed on 270 samples of fresh, retail-cut duck meat (60 samples of breasts, 95 samples of legs, 35 samples of wings and 80 samples of whole duck). Samples were analysed for the presence of pathogens such as: Salmonella sp., Listeria monocytogenes, and Campylobacter sp. Total bacterial count, Staphylococcus aureus, Enterobacteriaceae, lactic acid bacteria, molds and yeast were also determined. Examination of the duck meat revealed that the vast majority of samples (89%) were of satisfactory microbiological quality according to Commission Regulation (EC) No 2073/2005, as amended. Unsatisfactory quality was due to the presence of Salmonella sp. in 30 samples of duck meat. The most dominant pathogen isolated from duck meat was Campylobacter sp. (80%). Listeria monocytogenes was detected in 24% of duck meat. This study revealed that fresh duck meat is often contaminated with food spoilage microorganisms and pathogens that decreases the quality of this kind of meat and constitutes a public health hazards.

Key words: duck meat, microbiological quality, pathogens

INTRODUCTION

In Europe the main poultry meat producers are: France, UK, Spain, Germany, Italy, Poland and the Netherlands. The total poultry meat production includes chicken broilers, turkey and ducks. Duck meat is currently the third most widely produced poultry meat
after chicken and turkey [Sarjit, Dykes 2015]. The leading duck meat producer is France, supplying as much as 6% of the entire world duck meat production. In Poland the duck meat production per capita per year comes up to 0.4–0.5 kg and is similar to that recorded in Holland and Great Britain. Polish duck meat consumption is not as popular as chicken or turkey. The limited frequency of duck meat consumption is connected with relatively high price of the duck carcass and lack of tradition.

Duck meat combines the features of a red meat (high levels of phospholipids and haemminic pigments, rich in irone) as well the dietetic features of poultry meat (high content of unsaturated fatty acids). The duck is very appropriate for extensive production systems as its growth rate is lower than that of the chicken broiler. Moreover, its hardiness allows this species to adapt to unfavourable environmental conditions and resists to many common poultry diseases [Baéza 2006]. The main species used to produce duck meat in Poland is Pekin. The growing demand for this kind of fresh meat is observed between October to March.

Meat and meat products are favourable nutritive media for bacteria (Pseudomonas, Enterobacteriaceae, Micrococcaceae, Bacillus, Clostridium, Lactobacillus, etc.), yeast (Cryptococcus, Candida, Rhodotorula, etc.) and molds (Mucor, Thamnidium, Penicillium, etc.). Microflora growth on these products reduces their quality, nutritional value and duration of cold storage, moreover constitutes a public health hazard [Baranenko et al. 2013]. Raw poultry products are reported to be responsible for a significant number of cases of human food poisoning. In the absence of hygienic conditions, the birds may be highly exposed to bacterial pathogens such as Salmonella sp., Campylobacter sp., Listeria monocytogenes, Escherichia coli. In addition to pathogenic bacteria, special attention in the hygienic production and storage of poultry meat is paid also to total bacterial count, lactic acid bacteria, Enterobacteriaceae, yeast and moulds. These microorganisms are considered indicators of microbial quality [Adzitey et al. 2012a, Jamali et al. 2014, Li et al. 2013, Li et al. 2010].

Although duck meat has received growing attention, there are few studies in terms of its microbial quality during retail storage. Taking into account this fact in the Laboratory of Microbiology, Department of Food Quality, Institute of Agricultural and Food Biotechnology undertaken research aimed at determining microbial quality of duck meat available in local trade network.

**MATERIALS AND METHODS**

**Sampling**

Two hundred and seventy samples of four types of commercially available fresh duck meat were microbiologically analyzed between October 2013 and March 2014. The samples of meat were transported to the Laboratory of Microbiology in isothermal containers, maintaining the temperature at 0–2°C, and tested immediately on reaching the laboratory. A range of duck parts were analyzed, including: breast, legs, wings, and whole duck.
Microbiological and statistical analyses

The duck meat was evaluated in terms of food safety and hygiene of the process. All microbiological parameters were sampled and analysed following Polish Standards and Commission Regulation (EC) No 2073/2005 of 15.11.05 on the microbial criteria for foodstuffs, as amended. The pathogens investigated included the presence of: *Salmonella* sp., *Listeria monocytogenes*, *Campylobacter* sp. Additionally, total bacterial count (TBC), the number of *Enterobacteriaceae* (E), lactic acid bacteria (LAB), coagulase-positive *Staphylococcus* (CPS), yeast and moulds were enumerated using an Acolyte supercount colony counter (Synbiosis USA). API-tests (Biomerieux), Microgen Listeria ID (MicrogenBioproducts), and Singelpath (Merck) were performed for biochemical and serological determination. All microbiological tests were carried out in 5 replicates. Data from each replication were averaged and log 10 transformed. Results of microbiological analyses are reported as mean values standard deviation (S.D).

RESULTS

The frequency of pathogens detection in the tested duck meat is shown in Table 1. Examination of the meats revealed that the vast majority of samples (89%) were of satisfactory microbiological quality according to Commission Regulation (EC) No 2073/2005 as amended. Unsatisfactory quality was due to the presence of *Salmonella* sp. in 30 samples of different duck meat. The duck legs had the highest prevalence of *Salmonella* sp. (16%). The most dominant pathogen isolated from duck meat samples was *Campylobacter* sp. The prevalence of this genus ranged from 74% in duck legs to 92% in duck breasts. *Listeria monocytogenes* was the second most frequently isolated pathogen in this study (Table 1) with 24% of positive isolates.

The changes in counts of bacteria, yeast and moulds (log 10 CFUxg-1) for different duck products are shown in Table 2 and Figure 1. Total bacterial count displayed loads from 3.90 log 10 CFUxg-1 (legs) to 7.99 log 10 CFUxg-1 (wings). Coagulase-positive *Staphylococcus* were below the detection limit, except for one case: legs, whose counts increased to 2.41 log 10 CFUxg-1. The number of *Enterobacteriaceae* ranged between 0.00 log 10 CFUxg-1 (for legs, wings, whole duck) and 5.18 log 10 CFUxg-1 (for legs), while LAB grew up to 5.04 log 10 CFUxg-1 (whole duck). Moulds reached values from 0.00 log 10 CFUxg-1 to 3.77 log 10 CFUxg-1 for whole duck. By contrast the viable count of yeast was higher and grew over 4.95 log 10 CFUxg-1 (wings) (Table 2).

The results presented in Figure 1 reveals, that the mean value of the total bacterial count of divers parts of duck meat (breast, legs, wings, and whole duck) did not differ significantly with mean counts of log 10 CFUxg-1 being 5.06 ± 0.62, 5.44 ± 0.82, 5.81 ± 0.93, 5.23 ± 0.65 respectively. The mean value of yeast count in wings amounted to 4.11 ± 0.72 log10 CFUxg-1, whereas in legs reached 0.19 ± 0.15 log10 CFUxg-1 (Fig. 1).
Table 1. Frequency of isolated pathogens from tested duck meat  
Tabela 1. Częstotliwość izolowanych bakterii chorobotwórczych z mięsa kaczki

<table>
<thead>
<tr>
<th>Meat type</th>
<th>No. of meat samples</th>
<th>No./Percentage positive for Listeria monocytophages</th>
<th>No./Percentage positive for Salmonella sp.</th>
<th>No./Percentage positive for Campylobacter sp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breast Pierś</td>
<td>60</td>
<td>20/33%</td>
<td>5/8%</td>
<td>55/92%</td>
</tr>
<tr>
<td>Legs Nogi</td>
<td>95</td>
<td>20/21%</td>
<td>15/16%</td>
<td>70/74%</td>
</tr>
<tr>
<td>Wings Skrzydelka</td>
<td>35</td>
<td>5/14%</td>
<td>5/14%</td>
<td>30/86%</td>
</tr>
<tr>
<td>Whole duck Cała kaczka</td>
<td>80</td>
<td>20/25%</td>
<td>5/6%</td>
<td>60/75%</td>
</tr>
<tr>
<td>Total Sumarycznie</td>
<td>270</td>
<td>65/24%</td>
<td>30/11%</td>
<td>215/80%</td>
</tr>
</tbody>
</table>

Table 2. Microbiological load of tested duck meat  
Tabela 2. Ładunek mikrobiologiczny analizowanego mięsa kaczki

<table>
<thead>
<tr>
<th>Microbiological parameter</th>
<th>Product – Produkt</th>
<th>Breast Pierś</th>
<th>Legs Nogi</th>
<th>Wings Skrzydelka</th>
<th>Whole duck Cała kaczka</th>
</tr>
</thead>
<tbody>
<tr>
<td>Counts of microorganisms [log 10 CFU/g]</td>
<td>Liczba drobnoustrojów [log 10 jtk/g]</td>
<td>4.15–6.30</td>
<td>3.90–7.23</td>
<td>4.73–7.99</td>
<td>3.97–6.99</td>
</tr>
<tr>
<td>Lactic acid bacteria Bakterie fermentacji mlekowej</td>
<td>0.00–4.18</td>
<td>1.73–4.98</td>
<td>2.54–4.15</td>
<td>2.08–5.04</td>
<td></td>
</tr>
<tr>
<td>Enterobacteriaceae</td>
<td>2.00–3.62</td>
<td>0.00–5.18</td>
<td>0.00–4.79</td>
<td>0.00–4.26</td>
<td></td>
</tr>
<tr>
<td>Coagulase-positive Staphylococcus Gronkowce koagulazo-dodatnie</td>
<td>0.00</td>
<td>0.00–2.41</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>Molds Pleśnie</td>
<td>0.00–0.56</td>
<td>0.00–2.45</td>
<td>0.00–0.68</td>
<td>0.00–3.77</td>
<td></td>
</tr>
<tr>
<td>Yeast Droźdże</td>
<td>2.04–4.18</td>
<td>0.00–0.39</td>
<td>1.74–4.95</td>
<td>2.04–4.45</td>
<td></td>
</tr>
</tbody>
</table>
Occurrence of Campylobacter and Salmonella...

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**DISCUSSION**

Despite the high economic significance of the European duck industry, information on the microbiological quality of duck meat is rare [Adzitey et al. 2012c, Sarjit, Dykes 2015]. Taking into account this fact in the Laboratory of Microbiology, two hundred and seventy samples of four types of commercially available fresh duck meat were microbiologically analyzed.

*Campylobacter, Salmonella* and *Listeria monocytogenes* are of major public health concern worldwide due to the high burden of disease caused by these species [EFSA 2015, Molenda et al. 2008, Uradziński, Wyskok 2008]. In the present study all the above-mentioned pathogens were detected. However according to the Regulative EU [Commission Regulation 2073/2005, as amended], the only microbial parameter that can disqualify the duck meat is the presence of *Salmonella* sp.

In our survey *Salmonella* sp. was detected in 11% of the analysed duck samples. Incidence rates found by other authors in duck meat are similar. Adzitey et al. [2012b] showed the prevalence of this pathogens in duck meat at the level of 23.5%. The investigation carried out by Cha et al. [2013] determined that up to 65.2% of the South Korean ducks were contaminated with *Salmonella* sp. Nor Faiza et al. [2013] in Penang found that 16% ducks were infected with this microorganism.

*Listeria monocytogenes* was detected in 24% of analysed duck meat. The percentage of contaminated samples is higher than that of 2,8% found by Adzitey et al. [2013].

Our results indicate that *Campylobacter* sp. is highly prevalence in tested duck meat, which is similar to findings reported from Great Britain [Colles et al. 2011], and Tanzania [Nonga and Muhairwa 2010]. In our study *Campylobacter* sp. was detected in 80% samples. This percentage coincides with that of Nonga and Muhairwa [2010]. According to Colles et al. [2011] and Wei et al. [2014] the percentage of farmed duck samples positive for this pathogen was 93.3–100.0% and 96.6% respectively. Lower values were found by
Jamali et al. [2015] that reported 39.2% duck samples contaminated with *Campylobacter* sp. The differences among results might be due to diverse isolation methods, geographic, and seasonal factors [Adzitey et al. 2012c, Jamali et al. 2015]. Our survey, confirmed that ducks were more frequently contaminated with *Campylobacter* sp. than *Salmonella* sp. which is similar to findings reported by Adzitey et al. [2012a].

Duck meat is a highly perishable product due to its biological composition. Many interrelated factors influence the shelf life and freshness of such kind of meat, as storage temperature, atmospheric oxygen, endogenous enzymes, moisture, light and most importantly, microorganisms.

There are no safety criteria for duck meat, in terms of total bacterial count, *Enterobacteriaceae*, lactic acid bacteria, molds and yeast. According to Czarniecka-Skubina et al. [2007] a safe heat-treated poultry dish is achieved when the total bacterial count does not exceed $10^5$ CFUxg-1. Cooking and blast chilling of meat caused a 50% reduction in the number of aerobic bacteria and elimination of coli group bacteria in spite of a considerable initial count of aerobic bacteria $5.38–5.63$ log CFUxg-1. In the current study the mean microbial load varied from $5.06 \pm 0.62$ log 10 CFUxg-1 (breast) to $5.81 \pm 0.93$ log 10 CFUxg-1 (wings). However it must be taken into account, that the high level of these microorganisms is responsible for spoilage and shorten the shelf life of duck meat. Lactic acid bacteria were the predominant spoilage bacteria of duck meat which ranged from $2.55 \pm 1.33$ log 10 CFUxg-1 in duck breast to $3.52 \pm 0.52$ log 10 CFUxg-1 in duck wings. This level is in accordance with Liu et al. [2010], who found in fresh water-boiled salted duck, total bacterial count and lactic acid bacteria at the levels $4.96 \pm 0.10$ and $4.63 \pm 0.03$ log 10 CFUxg-1, respectively.

Bacteria such as *Salmonella*, *Campylobacter* and *Listeria monocytogenes* are widespread in the environment, and commonly found on duck farms. Contaminated feed and flocks are the main route of introduction of these microorganisms. Protecting from pathogen contamination is an extremely important component of commercial duck production. Implementing daily biosecurity protocols as best management practices on duck farms can reduce the possibility of introducing zoonotic microbiological infections.

**CONCLUSION**

Our study revealed that fresh duck meat is often contaminated with food spoilage microorganisms and pathogens that decreases the quality of this kind of meat and constitutes a public health hazards. The most dominant pathogen isolated from duck meat samples was *Campylobacter* sp.

**Acknowledgments**

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Commission Regulation (EC) No 2073/2005 of 15.11.05 on the microbial criteria for foodstuffs, as amended.


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**WYSTĘPOWANIE CAMPYLOBACTER SP. I SALMONELLA SP. W POLSKIM MIĘSIE KACZKI W OBECNOŚCI INNYCH GRUP DROBNOUSTROJÓW ODPOWIEDZIALNYCH ZA PSUCIE SIĘ MIĘSA**

**Streszczenie.** W artykule przedstawiono wyniki badań jakości mikrobiologicznej mięsa kaczki sprzedawanego na polskim rynku. Według naszej wiedzy jest to pierwszy raport dotyczący szerszej analizy mikroflory kaczej mięsa. Analizę bacteriologiczną przeprowadzono na 270 próbkach świeżego mięsa kaczki, dostępnego w handlu detalicznym, różnego typu, obejmującego 60 próbek filetów piersi, 95 próbek nóg, 35 próbek skrzydeł i 80 próbek całej kaczki. W zakupionych próbkach analizowano obecność patogenów takich jak: Salmonella sp., Listeria monocytogenes i Campylobacter sp. Ponadto, określano ogólną liczbę bakterii, liczbę Staphylococcus aureus, liczbę Enterobacteriaceae, liczbę bakterii kwasu mlekowego oraz liczbę pleśni i drożdży. Badania wykazały, że zdecydowana większość próbek mięsa kaczki (89%) była zadowalającej jakości mikrobiologicznej zgodnie z rozporządzeniem Komisji (WE) nr 2073/2005, z późniejszymi zmianami. Niezadowalająca jakość była ze względu na obecność bakterii Salmonella sp. w 30 próbkach mięsa.
kaczki. Najbardziej dominującym patogenem izolowanym z mięsa kaczki był Campylobacter sp. (80%). Bakteria Listeria monocytogenes wykryto w 24% próbek mięsa kaczki. Przeprowadzane badania dowiodły, że świeże mięso kaczki jest często zanieczyszczone nie tylko patogenami, ale również mikroorganizmami odpowiedzialnymi za psucie się żywności, przez co mięso takie stanowi zagrożenie dla zdrowia publicznego, a jego jakość znacznie się obniża.

Słowa kluczowe: mięso kaczki, jakość mikrobiologiczna, patogeny

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