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Microbiological quality of poultry meat on the Croatian market

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ABSTRACT

This paper presents an investigation of the microbiological quality of poultry meat sold on the Croatian market. Bacteriological analysis was performed on 66 samples of fresh, retail-cut chicken meat (21 samples of chicken breasts without skin - "fillet", and 19 samples of chicken breasts with skin) and frozen ground chicken meat (26 samples). Samples were collected from retailers (kept in cooling showcases at +4 ºC, deep-freezers at -18 ºC, respectively), and then bacteriologically tested for the presence of bacteria *Salmonella* spp., *Listeria monocytogenes*, *Staphylococcus aureus*, *Enterobacteriaceae*, *Campylobacter* spp., and sulphite-reducing clostridia. Total count of aerobic mesophilic bacteria was also determined. Bacteriological tests were performed by means of standard methods of isolation and identification of individual species of bacteria according to ISO requirements. API-tests (Biomerieux) and BBL Identification System (Becton-Dickinson) were used for biochemical determination. With regard to microbiological quality and contamination of chicken meat, of importance is the finding of *Salmonella* spp. (10.60%), *S. aureus* (30.30%), *L. monocytogenes* (3.03%), enterobacteria (34.84%) and sulphite-reducing clostridia (1.50%). *Campylobacter* spp. were not found in any of the analysed samples. Total bacteria count found in frozen ground chicken meat was 5.23 ± 0.50 $\log_{10}$ CFU/g, whilst it was lower in cut chicken meat. Total bacteria count in chicken breast fillets amounted to 4.72 ± 0.38 $\log_{10}$ CFU/g, $3.67 \pm 0.88 \log_{10}$ CFU/g in chicken breasts with skin, respectively. Results of the study suggest that a significant risk of meat spoilage and an increase in the number and species of bacteria depend on the specific part of analysed chicken meat, mode of packaging and storage after distribution to the market.

Key words: poultry meat, *Salmonella* spp., *Listeria monocytogenes*, *S. aureus*, *Enterobacteriaceae*, *Campylobacter* spp., sulphite-reducing clostridia

Introduction

Production and consumption of poultry meat and poultry meat products show an upward trend. This, of course, requires adequate control and inspection both during poultry

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rearing and in slaughterhouses, processing plants and shops. Consumers are also a link in the chain of food-borne human diseases, because of the way they store and cook poultry meat and meat products.

Special attention in poultry meat production is paid to the fact that live animals are hosts to a large number of different microorganisms residing on their skin, feathers or in the alimentary tract. During slaughter most of these microorganisms are eliminated, but subsequent contamination is possible at any stage of the production process, from feather plucking, evisceration, and washing to storage by cooling or freezing. Microorganisms from the environment, equipment and operators' hands can contaminate meat (MEAD, 1989; ŽIVKOVIĆ, 2001). During the process, the microflora changes from, in general, Gram-positive rods and micrococci to, most frequently, Gram-negative bacteria in final products, including enterobacteria, *Pseudomonas* spp., etc. Industrial poultry slaughterhouses have a particular technological process, the individual stages of which are not in conformity with modern principles of hygienic meat production and processing. ŽIVKOVIĆ (1990) has pointed out the speed of processing on conveyors that, together with negative consequences of meat and equipment contact (feather plucking, evisceration, etc.), makes the control of adverse effects of technology on meat quality and safety practically impossible. High concentrations of poultry, slaughtering and processing equipment and cooling devices can be the cause of significant bacterial contamination, and also of a shorter meat shelf life. Some stages of the technological process of production in poultry slaughterhouses (scalding, evisceration) are responsible for increased bacterial contamination. This primarily refers to cross-contamination of poultry meat with causal agents of infections and intoxications in men.

An efficacious way of preventing food-borne human diseases is to monitor the microbiological quality of poultry meat and meat products during production, storage and distribution. Epidemiological reports suggest that poultry meat is still the primary cause of human food poisoning (MULDER, 1999). According to FRIES (2002), the microflora of poultry is transferred from the primary production sites to production lines, and further, by subsequent contamination. Microflora of crude chicken meat is heterogeneous and originates from slaughtering premises, operators' hands, equipment and outfit, and water and air (ANONYM., 1996). Contamination with pathogenic bacteria, in particular *Salmonella*, plays an important role in the veterinary-sanitary control of meat. FRIES (2002) has pointed out the significance of subsequent contamination of meat with *Salmonella* spp. during slaughterhouse processing of poultry. According to study results obtained by ŽIVKOVIĆ et al. (1997a), positive findings of *Salmonella* spp. in chicken meat and viscera amounted to 8.6% (n = 910), 11.5% (n = 26) in retail cut meat, 3.9 % (n = 672) in carcass meat, and 23.1% (n = 212) in viscera, respectively. Poultry is the main source of bacteria of the genus *Campylobacter* and carriers of *C. jejuni* have been found in many poultry flocks. However, birds not affected with Campylobacteriosis may become contaminated in the

course of slaughter. Contamination of carcasses with this bacterium may be as high as 50% and more (MEAD, 1989; STERN et al., 1994). In a study performed by ATANASSOVA and RING (1997), the level of contamination of poultry meat with *Campylobacter* spp., mostly *C. jejuni*, was 50.9%. Ubiquity of bacteria of the genus *Listeria* is an important factor influencing the possibility of poultry meat contamination. Presence of *L. monocytogenes* in fresh broiler meat varies from 0% to 64% (LONCAREVIC et al., 1994). ŽIVKOVIĆ et al. (1997b) have isolated *Listeria* spp. in 27.8% of fresh chicken samples. CAPITA et al. (2002a) have emphasised the significance of the presence of *Yersinia* spp. in chicken meat, which had been found in 65% of samples of retail chicken carcasses. Contamination with *S. aureus* is important in the evaluation of safety and hygienic quality of chicken meat, but also in the aetiology of food poisoning (JABLONSKI and BOHACH, 1997).

In addition to pathogenic bacteria, special attention in the hygienic production and storage of chicken meat is paid also to total count of aerobic mesophilic bacteria, enterobacteria and *Escherichia coli*. These bacteria are considered indicators of microbiological quality (STOLLE 1988; NORTJE et al., 1990; ABU-RUWAIDA et al., 1994; ALVAREZ-ASTORGA et al., 2002; CAPITA et al., 2002b). Total count of aerobic mesophilic bacteria in ground chicken meat is always high, and consequently the risks of spoilage in the sense of microbiological disintegration are higher (ALVAREZ-ASTORGA et al., 2002).

In relation to the above-mentioned, the aim of the study was to investigate microbiological quality of both fresh cut and frozen ground chicken meat sold on the domestic market.

Material and methods

Sixty-six samples of chicken meat were collected from retailers, of which 21 samples were of chicken breasts without skin (”fillet”), 19 samples of chicken breasts with skin and 26 samples of frozen, ground chicken meat. Ground chicken meat was kept in deep-freezers (temperature -18 ºC), and fresh chicken meat in cooling showcases (temperature +4 ºC).

Collected samples were bacteriologically tested for the presence of *Salmonella* spp., *Listeria monocytogenes*, *Staphylococcus aureus*, *Enterobacteriaceae*, *Campylobacter* spp. and sulphite-reducing clostridia. Total count of bacteria was also determined. Bacteriological tests were performed by means of standard methods of isolation and identification of individual species of bacteria according to ISO requirements (ISO 6579:2002; ISO 11290-1:1996; ISO 6888-1; ISO 7402:1993; ISO 10272:1995; ISO 4833:1991). The isolation of sulphite-reducing clostridia was carried out by Sulphite agar (Biolife; 24-72 h/37 ^{0}C). API-tests (API 20E; API *Listeria*; API Staph; Biomerieux) and BBL Identification System (Gram Positive ID Kits; Becton-Dickinson) were used for biochemical determination.

Results and discussion

Study results are presented in Figures 1-3.

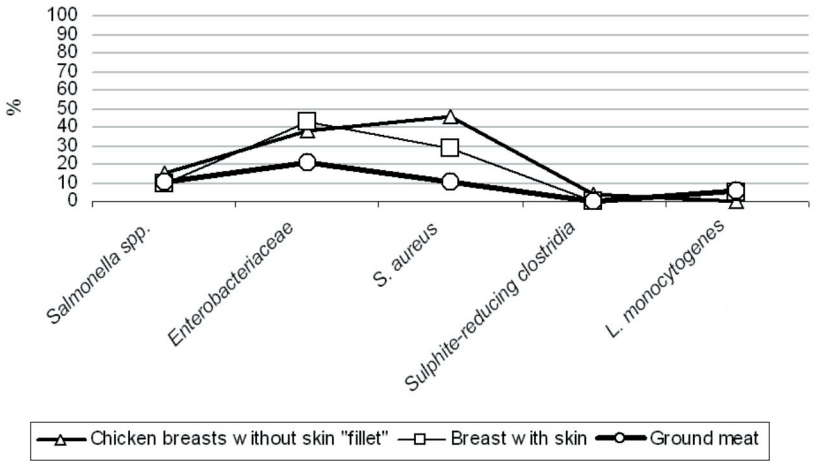


Fig. 1. Results of bacteriological analysis of retail cut and ground chicken meat. **Campylobacter* spp. not isolated

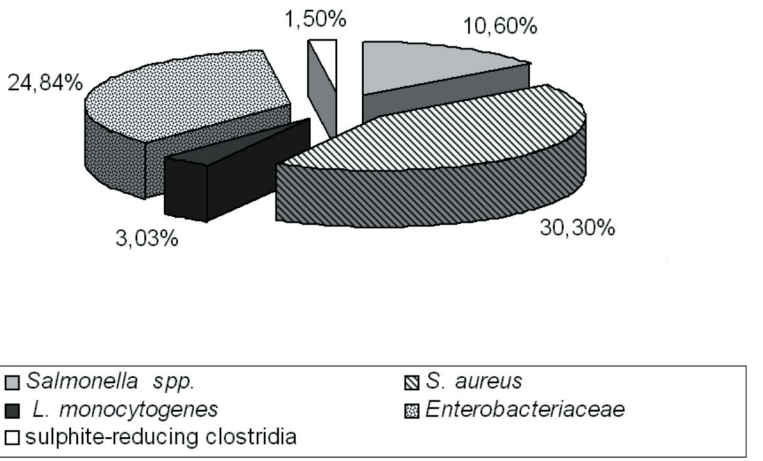
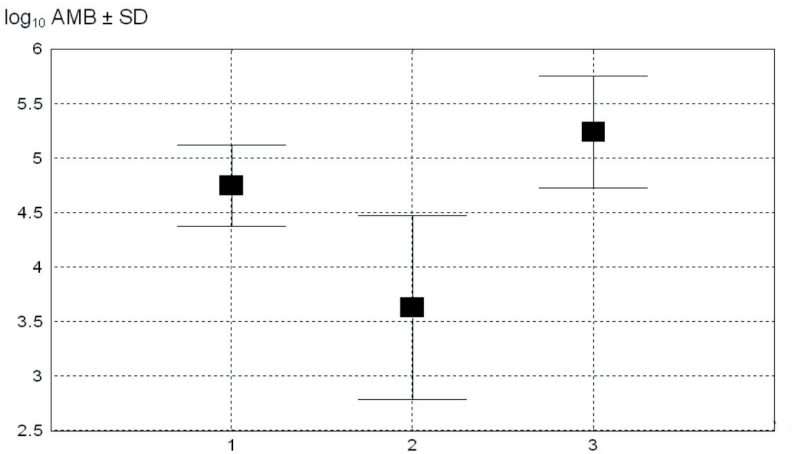


Fig. 2. Positive finding of bacteria in samples of chicken meat (n = 66)



1 - chicken breasts without skin "fillet"; 2 - breasts with skin; 3 - ground meat

Fig. 3. Total count of aerobic mesophilic bacteria (AMB)

Salmonella spp. were found in 15.39% of chicken breast fillets and in 9.52% of chicken breasts with skin. *Salmonella*e were also isolated from 10.53% of samples of frozen ground meat (Fig. 1). Results are similar to those (11.5%) recorded by ŽIVKOVIĆ et al. (1997a). Chicken breasts with skin were of inadequate microbiological quality also because of the finding of *L. monocytogenes* (4.76% of analysed samples). This microorganism was also isolated from 5.26% samples of ground chicken meat. Sulphite-reducing clostridia were found in one sample of chicken breasts without skin.

S. aureus was found in 46.15% samples of chicken breast fillets and in 28.75% samples of breasts with skin (Fig. 1). Total count of *S. aureus* ranged from 1.70 to 3.69 $\log_{10}$ CFU/g. The average number of *S. aureus* amounted to 2.74 ± 0.56 $\log_{10}$ CFU/g in chicken breast fillets, 2.98 ± 0.35 $\log_{10}$ CFU/g in breasts with skin, respectively. KREYENSCHMIDT et al. (2002) have evaluated the shelf life of poultry meat and have isolated *S. aureus* from samples of chicken retail cut meat stored at 10 °C (1000/g) and *Staphylococcus* spp. (5×10^4/g) from meat stored at 4 °C. According to ALVAREZ-ASTORGA et al. (2002), the finding of *S. aureus* is the principal reason for the inadequate microbiological quality of chicken meat sold on the Spanish market (2.47 $\log_{10}$ CFU/g in drumsticks and 3.48 $\log_{10}$ CFU/g in wings). ABU RUWAIDA et al. (1994) have also pointed out the importance of the finding of *S. aureus* in chicken meat (4.1 $\log_{10}$ CFU/g), 2.3-3 $\log_{10}$ CFU/g, respectively, according to the results obtained by MEAD et al. (1993).

Enterobacteria were found in 38.47% of chicken breasts without skin and in 42.85% of breasts with skin (Fig. 1). The average number of enterobacteria in fillets amounted to 3.62 ± 0.48 $\log_{10}$ CFU/g, 2.28 ± 0.52 $\log_{10}$ CFU/g in chicken breasts with skin, respectively. These results are comparable with those reported by CAPITA et al. (2002b), i.e. enterobacteria in retail cut chicken meat amounted to 2.58-3.53 $\log_{10}$ CFU/g. In our study, enterobacteria count in samples of cut chicken meat was 2.00-4.17 $\log_{10}$ CFU/g, less than reported by the above-mentioned authors.

Number of enterobacteria in 21.05% of analysed samples of ground chicken meat (Fig. 1) ranged from 1.7 to 3.07 $\log_{10}$ CFU/g (average 2.13 ± 0.64 $\log_{10}$ CFU/g). Bacterium *S. aureus* was found in 10.53% of cases (average 2.46 ± 1.08 $\log_{10}$ CFU/g). These latter results are lower than those (3.19 $\log_{10}$ CFU/g) reported by ALVAREZ-ASTORGE et al. (2002) or MORENO et al. (1997) (quot. ALVAREZ-ASTORGA et al., 2002), i.e. 3.60 $\log_{10}$ CFU/g.

Overall, bacteria of *Salmonella* spp. were found in 10.60% of chicken meat samples, *S. aureus* in 30.30%, enterobacteria in 24.84%, *L. monocytogenes* in 3.03% and sulphite-reducing clostridia in 1.5%, respectively. *Campylobacter* spp. were not found in any of analysed samples (Fig. 2).

Total number of aerobic mesophilic bacteria ranged from 2.30 - 5.41 $\log_{10}$ CFU/g in samples of retail cut chicken meat. It was higher in fillets, averaging to 4.72 ± 0.38 $\log_{10}$ CFU/g, and a little lower in breasts with skin, 3.67 ± 0.88 $\log_{10}$ CFU/g (Graph 3). Total bacteria count of 4.4 $\log_{10}$ CFU/g in chicken breast meat was reported by SALEH et al. (1997). According to study results reported by ALVAREZ-ASTORGA et al. (2002), total bacteria count in chicken drumsticks amounted to 5.79 $\log_{10}$ CFU/g, in addition to a high average bacteria count of 5.85 $\log_{10}$ CFU/g in chicken wings. Total bacteria count in samples of ground meat (Graph 3) was, on average, 5.23 ± 0.50 $\log_{10}$ CFU/g. Samples of ground chicken meat analysed by ALVAREZ-ASTORGA et al. (2002) contained 6.29 $\log_{10}$ CFU/g of mesophilic bacteria, significantly higher ($P<0.05$) than in samples of cut meat. RASHAD (1990) has found 4.32 to 6.38 $\log_{10}$ CFU/g of aerobic mesophilic bacteria in ground chicken meat. Similar results have been reported by EL-KHATEIB (1997), i.e. 4.04 - 8.00 $\log_{10}$ CFU/g of aerobic mesophilic bacteria. As regards total bacteria count of aerobic mesophilic bacteria recorded in other studies, results of our study show that the overall hygienic quality of chicken meat has been significantly higher.

Comparison of results of bacteriological analysis of chicken breasts without and with skin shows that fillets contained a higher number of *Salmonella*e, as well as *S. aureus* and *L. monocytogenes*. Also, the average total count of aerobic mesophilic bacteria was higher in chicken breasts without skin compared with chicken breasts with skin. A higher number of aerobic mesophilic bacteria was found in ground meat compared with cut meat. Results of our study confirm the conclusions reached by other researchers that both cut and ground chicken meat is contaminated with a high number of microorganisms. These findings are

indicative of contamination and inadequate hygienic conditions in the production and processing of poultry meat (MULDER, 1999; ŽIVKOVIĆ, 2001; FRIES, 2002; ALVAREZ-ASTORGA et al., 2002; CAPITA et al., 2002a).

Conclusion

The reason for the inadequate microbiological quality of cut and ground chicken meat was the finding of *Salmonellae*, *S. aureus*, *L. monocytogenes* and enterobacteria, and a high number of aerobic mesophilic bacteria. Bacteria of *Salmonella* spp. were found in 10.60% of chicken meat samples, *S. aureus* in 30.30%, enterobacteria in 24.84%, *L. monocytogenes* in 3.03% and sulphite-reducing clostridia in 1.5%. Microorganisms of *Campylobacter* spp. were not found in any of analysed samples. The average number of aerobic mesophilic bacteria was the highest in samples of ground chicken meat (5.23 $\log_{10}$ CFU/g), while in chicken breast without skin (fillet) it amounted to 4.72 $\log_{10}$ CFU/g, 3.67 $\log_{10}$ CFU/g in chicken breasts with skin, respectively. Results of our study suggest that a significant risk of meat spoilage and an increase in the number and species of bacteria depend on the specific part of analysed chicken meat, mode of packaging and storage after distribution to the market.

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SAŽETAK

U radu je istraživana mikrobiološka kakvoća pilećega mesa na domaćem tržištu. Bakteriološkom pretragom obuhvaćeno je 66 uzoraka svježega konfekcioniranoga (pileća prsa bez kože, "file" - 21 uzorak i pileća prsa s kožom - 19 uzoraka) i smrznutoga usitnjenoga pilećega mesa (26 uzoraka). Uzorci su uzeti iz maloprodaje (rashladne vitrine, +4 ºC, odnosno ledenice, -18 ºC). Bakteriološkom pretragom obuhvaćen je nalaz bakterija *Salmonella* spp., *Listeria monocytogenes*, *Staphylococcus aureus*, *Enterobacteriaceae*, *Campylobacter* spp., sulfitreducirajućih klostridija te ukupni broj aerobnih mezofilnih bakterija. Bakteriološke pretrage izvršene su uobičajenim postupcima izdvajanja i identifikacije pojedinih vrsta bakterija prema ISO normama. U biokemijskoj determinaciji primijenjeni su API-testovi (Biomerieux) i BBL Identification System (Becton-Dickinson). S obzirom na mikrobiološku kakvoću i nalaz mikroorganizama u pretraženim uzorcima pilećega mesa značajan je nalaz *Salmonella* spp. (10,60%), *S. aureus* (30,30%), *L. monocytogenes* (3,03%) te enterobakterija (34,84%) i sulfitreducirajućih klostridija (1,50%), dok bakterije roda *Campylobacter* nisu utvrđene niti u jednom pretraženom uzorku. Najveći ukupni broj bakterija utvrđen je u smrznutom usitnjenom pilećem mesu ($5,23 \pm 0,50$ $\log_{10}$ CFU/g), dok je u konfekcioniranoj piletini bio manji i u "fileima" pilećih prsiju iznosio $4,72 \pm 0,38$ $\log_{10}$ CFU/g, a u pilećim prsima s kožom $3,67 \pm 0,88$ $\log_{10}$ CFU/g. Rezultati pretrage upućuju na značajan rizik u smislu kvarenja i povećanja broja i vrste bakterija ovisno o "poziciji" konfekcioniranoga dijela mesa, kao i načinu pakiranja i pohrane u tijeku prometa na tržištu.

Ključne riječi: pileće meso, *Salmonella* spp., *Listeria monocytogenes*, *Staphylococcus aureus*, *Enterobacteriaceae*, *Campylobacter* spp., sulfitreducirajući klostridiji