

## MICROBIOLOGICAL SAFETY OF MEAT AND MEAT PRODUCTS IN THE REPUBLIC OF MACEDONIA

**Snezana Ivic-Kolevska<sup>1\*</sup>, Biljana Miljkovic-Selimovic<sup>2</sup>, Branislava Kocic<sup>2</sup>**

<sup>1</sup>**Institute of Public Health of the Republic of Macedonia, 50 Divizija, 6, 1000, Skopje, Republic of Macedonia**

<sup>2</sup>**Institute for Public Health, Zorana Đinđića 50, 18000, Nis, Republic of Serbia**

**\*e-mail: snezanaivickolevska@hotmail.com**

### Abstract

Aim of this paper is to assess the microbiological contamination of meat and meat products in Macedonia from 2003 to 2008 and determine the most frequent agents for microbiological contamination of these products.

All samples were tested in the authorized laboratories for food safety for the period 2003-2008. All examinations were accomplished using standard microbiological techniques.

Percentage of microbiological unsafe meat from import was in the range 0.4 to 7.6%, but meat products from import were microbiologically safe (0.5% contamination). Microbiological unsafe meat from domestic production and retail were in the range 7.3% to 12.3%. Meat products in highest percentage were unsafe in 2004-10% with significant decrease in next years. The most frequently isolated agent for microbiological contamination was *Salmonella* species (27 to 75%), followed by *Proteus* species (30.6 to 50%), *E.coli* (9 to 32.5%) and coagulase positive *Staphylococcus* (11.3 to 32.6%).

Meat and meat products from domestic production were microbiologically unsafe in higher percentage compared with import products. Foodborne diseases are significant public health problem and for their prevention a full collaboration between physicians, veterinarians and all subjects involved in food production and retail is needed.

**Key words:** *Microbiological contamination, meat, meat products, Salmonella sp., E. coli.*

are required to maintain its safety. Meat from healthy animals is sterile or contains a small number of live bacteria, but in the course of processing it is exposed to numerous chances for contamination (Aleksandar [1]). Depending on the level of hygiene during the slaughter, the speed of cooling and storage conditions of meat, a variety of aerobic, anaerobic and facultative anaerobic microorganisms can emerge that might contaminate meat and meat products.

At low temperatures the most common contaminants are psychrophilic and psychrotolerant microorganisms, and at high temperatures the most present are mezophilic and thermophilic microorganisms.

The most common microorganisms found in fresh beef, pork and sheep meat are: enterobacteria, *Pseudomonas*, *Shewanella putrefaciens*, *Alcaligenes*, *Flavobacterium*, *Acinetobacter*, *Moraxella*, *Psychrobacter*, *Brochotrix thermosphacta*, *Lactobacillus*, *Carnobacterium*, *Streptococcus*, *Leuconostoc*, *Micrococcus*, *Staphylococcus*, coryneform bacteria, *Bacillus*, *Clostridium*, and from fungi and molds: *Cladosporium*, *Sporotrichum*, *Scopularyopsis*, *Tamnidium*, *Mucor*, *Penicillium*, *Alternaria*, *Monillia* and *Aspergillus* (Adak *et al.* [2] Codex Alimentarius [3] and Buzby and Roberts [4]).

The objectives of this research were to determine the trend of microbiological contamination of meat and meat products in the Republic of Macedonia in the period from 2003 to 2008 and to determine the most common agents of microbiological contamination of meat and meat products.

### 1. Introduction

Meat plays a significant role in the diet of humans as a source of essential amino acids of animal origin and micronutrients, but also meat can easily deteriorate; hence, special storage conditions, transport and trade

### 2. Materials and Methods

We present a retrospective analysis of microbiological findings of meat and meat products tested in certified laboratories for sanitary microbiology in Macedonia

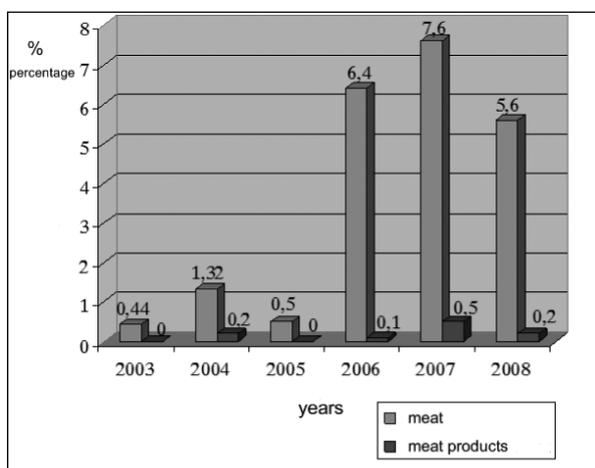
in the period between 2003 and 2008. Data from the annual reports on implementation of the Program for Preventive Health Care of Macedonia were used for analysis of microbiological safety. The analysis of microbiological safety of meat and meat products were performed with standardized methods and evaluated in accordance with the Regulations on the conditions regarding the microbiological safety, on which regulations animal foods from the market must be in concordance (Official Gazette of the Republic of Macedonia, N° 45/83).

The following microorganisms were investigated: *Salmonella* species according to ISO 6579, *Staphylococcus* coagulase positive ISO 16654, *Escherichia coli* (*E. coli*), *Proteus* species, sulfidoreducing *Clostridium*, bacterial contaminants, yeasts and molds.

The identification of isolated microbial agents was carried out by biochemical (Vitek-system (BioMerieux, France)) or serological confirmation (slide agglutination-O, H, VI antigen in *Salmonella* or slide agglutination with antiserum suitable for *E.coli* O157:H7) or both, depending on the suspected microorganism. During the investigation two immunological techniques were used: VIDAS (BioMerieux) short fluorescence enzyme immunoassay technique for detection of *Escherichia coli* O157 antigen and enterotoxin of coagulase positive *Staphylococcus* and *Singlepath* test (Merck, Germany)-immunochromatographic rapid test for detection of *Escherichia coli* O157 antigen.

### 3. Results and Discussion

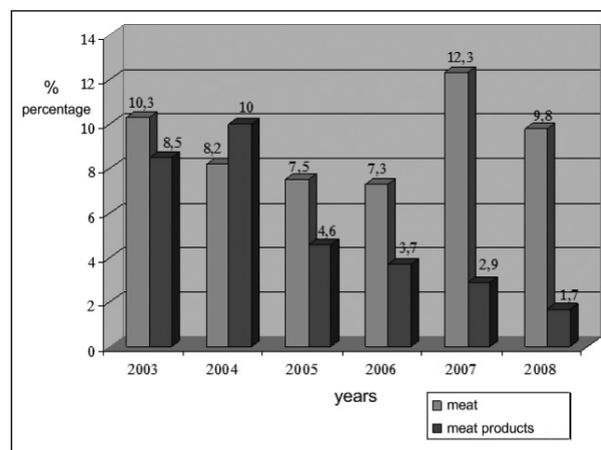
Microbiological contamination of meat from import ranged from 11 (0.4%) in 2003 and 10 (0.5%) in 2005, then it significantly increased to 97 (6.4%) in 2006, 114 (7.6%) in 2007 and 62 (5.6%) in 2008. Meat products from import were microbiologically contaminated in a lesser range-3 (0.5%) in 2007, 1 (0.2%) in 2004 and 2008 and 1 (0.1%) in 2006 (Figure 1).



**Figure 1. Percentage of microbiological contamination of meat and meat products from import**

In terms of the total number of tested samples of meat and meat products from domestic production and trade, there was a significant increase in the percentage of microbiologically contaminated meat in comparison with microbiological contamination of meat products.

Microbiological contamination of meat from domestic production and trade ranged from 25 (7.3%) in 2006 and 28 (7.5%) in 2005, to 46 (10.3%) in 2003 and 35 (9.8%) in 2008, with the highest percentage in 2007 (45 to 12.3%). Meat products were mostly contaminated in 2004 (198-10%) and 2003 (164 -8.5%), while a significant decline was noticed in 2005 (74-4.6%), in 2007 (43-2.9%) and in 2008 (15-1.7%) (Figure 2).



**Figure 2. Microbiological contamination of meat and meat products from domestic production and trade, expressed in percent**

The most common cause of microbiological contamination of meat and meat products from domestic production and trade by years was *Salmonella* species-16 (75%) in 2003, 31 (45.2%) in 2007 and 33 (27.3%) in 2008. *Proteus* species was isolated in 78 (44.9%) tested products in 2003, 81 (34.6%) in 2004 and 2005, then 36 (30.6%) in 2006 and 56 (33.9%) in 2007. *E. coli* was present in 245 (20%) in 2003, 400 (32.5%) in 2004 and 2005, 17 (8.9%) in 2006, 200 (14.5%) in 2007 and in 115 (10.4 %) tested products in 2008. The presence of *Staphylococcus* coagulase positive ranged from 141 (32.6%) in 2003, 289 (30.1%) in 2004 and 2005, to 185 (24.7%) in 2006, 150 (11.3%) in 2007 and 68 (22.1%) in 2008. *Sulfidoreducing Clostridium* was present in 12 (33.3%) in 2003, 11 (18.2%) in 2004 and 2005, then in 16 (6.3%) products in 2007. Yeasts were detected in 20 (20%) of total contaminated samples of meat and meat products from domestic production and trade in 2006 and 22 (31.8%) in 2007. Mold in larger number than allowed was detected in 28 (14.3%) of samples tested in 2006 (Table 1).

**Table 1. Frequency of microbiological contaminants in meat and meat products from domestic production and trade**

Microbes	Year											
	2003		2004		2005		2006		2007		2008	
	N°	%										
<i>Salmonella</i>	16	75	0	0	0	0	82	14,6	31	45,2	33	27,3
<i>Staph. coagulante positive</i>	141	32,6	289	30,1	289	30,1	185	24,7	150	11,3	68	22,1
<i>Clostridium sulfido-reductive</i>	12	33,3	11	18,2	11	18,2	0	0	16	6,3	0	0
<i>Proteus sp.</i>	78	44,9	81	34,6	81	34,6	36	30,6	56	33,9	21	9,5
<i>E. coli</i>	245	20	400	32,5	400	32,5	17	8,9	200	14,5	115	10,4
<i>Yeast</i>	0	0	0	0	0	0	20	20	22	31,8	0	0
<i>Mold</i>	0	0	0	0	0	0	28	14,3	0	0	0	0
<i>Bacterial contamin.</i>	94	9,6	176	30,7	176	30,7	62	11,3	207	11,6	52	7,6

Increased number of bacteria contaminants ranged between 176 (30.7%) in 2004 and 2005 and 62 (11.3%) in 2006, 207 (11.6%) in 2007 and 52 (7.6%) in 2008 (JZO Republicki Zavod za zdravstvena zastita [5], [6], [7], [8], [9] and [10]).

Recent research has shown that around 130 million EU citizens per year suffer from diseases whose main cause is unsafe food. Diarrhea is the commonest cause of mortality and delayed growth in children. Contaminated food leads to disease in a large number of people, which reflects directly on their working ability, absence from work, reduced income and increased health care costs (James [11] and Pina *et al.* [12]).

The analysis of microbiological safety of meat and meat products shows a significantly greater microbiological contamination of meat and meat products from domestic production and trade.

Microbiological contamination of meat from import has been increasing in the last three years (2006-2008), due to increased imports of meat and more frequent control of the same products, while import of meat products is insignificantly microbiologically unsafe.

In the same period, there has been a marked increase in percentage of microbiological contamination of meat in comparison with microbiological contamination of meat products from domestic production and trade. Reports of the European Agency for Food Safety and the WHO Office for Food Safety for the European region from 2001 to 2005 present a reduced rate of morbidity from salmonellosis in the human population, placing it on the second place in terms of disease-related food. The most often contaminated food with *Salmonella* are eggs, chicken and pork meat (EFSA [13]).

The percentage of isolated *Salmonella* is different in EU countries, depending on the stage of processing and trade of meat; thus, in slaughterhouses the percentage of *Salmonella* ranges between 2.3% and 9.1%, while in the process of processing the meat in Estonia the percentage of positive isolates was up to 21.5% (EFSA [13]). In the trade (retail) the percentage of positive isolates ranged between 2.2% and 18.2% (EFSA [13]).

In the Laboratory of Sanitary Microbiology at the Institute of Public Health of the Republic of Macedonia identification for each isolated *E.coli* is being performed. During 2006, 18 meat samples and meat products were contaminated with *E.coli*, and in 9 of them (50%) *E.coli* O157 was identified while the total isolated *E.coli* in meat and meat products in 2007 was 51 of which 9 (17.6%) were *E.coli* O157. During 2008, *E. coli* was isolated from 12 samples of meat and meat products; in 4 of them (33.3%) *E. coli* O157 was confirmed. The percentage of isolated *E. coli* O157 is an issue to worry about since it is a very invasive pathogenic microbial agent that can give fatal consequences. Samples identified with *E. coli* O157 are/were actually samples of fresh chicken meat (John [14], Abdul-Raouf *et al.* [15] and Johnson and Durham [16]).

#### 4. Conclusions

- Meat and meat products from domestic production and trade have a higher percentage of microbiological contamination compared to meat and meat product imports. Although the trend of microbiological contamination of domestic products is decreasing, still there is a significantly high percentage of contamination. These findings indicate the need for introducing enhanced process of control in processing, storage and trade of these perishable products. The control should be strengthened mainly by food operators themselves through introduction of Good Hygienic Practice, Good Manufacturing Practice and control systems of food safety based on HACCP, but also by the competent authorities. The most common isolation of *Salmonella* as a cause of microbiological contamination, which is of animal origin, indicates that control should be introduced even in slaughterhouses themselves, then continue to maintain the cold chain of meat and meat products to prevent growth of microorganisms. Besides *Salmonella*, the most common isolates were *Proteus* species, *E. coli* and *Staphylococcus coagulase positive*, indicating the need to strengthen the personal hygiene of food operators and improving their knowledge on hygienic food handling.

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