CAMPYLOBACTERIOSIS: IMPORTANCE OF STRENGTHENING SURVEILLANCE AND REPORTED FOODBORNE DISEASE CONTROL WITHIN EUROPEAN UNION

Lucia Zeleňáková[1]*, Jana Žiarovská[2], Dagmar Kozelová[1], Ladislav Mura[3], Ľubomír Lopašovský[1], Alica Bobková[1], Peter Zajác[1], Jozef Čapla[1], Katarína Tináková[4]

Address: [1]Slovak University of Agriculture in Nitra, Faculty of Biotechnology and Food Sciences, Department of Food Hygiene and Safety, Tr. A. Hlinku 2, 949 76 Nitra, Slovak Republic

[2] Slovak University of Agriculture in Nitra, Faculty of Agrobiology and Food Resources, Department of Genetics and Plant Breeding, Tr. A. Hlinku, 949 01 Nitra, Slovak Republic

[3]Dubnica Institute of Technology, Sládkovičova 533/20, 018 41 Dubnica nad Váhom, Slovak Republic

[4]The Regional Public Health Authority, Štefánikova 8, 949 01 Nitra, Slovak Republic

*Corresponding author: lucia.zelenakova@uniag.sk

ABSTRACT

The aim of the work was to analyze the changes in the epidemiology of campylobacteriosis diseases in Slovakia over the past 10 years and evaluate them in the context of epidemiological changes comparing to the EU. Campylobacteriosis (A045) belong to the diseases with the highest morbidity in Slovakia. Campylobacteriosis remained by far the most frequently reported zoonotic disease in humans in Slovakia as well as in EU. For the period of 2001-2010 was reported in Slovakia25 574 campylobacteriosis cases. Most diseases were reported in 2010 with the number 4591 (84.63 morbidity/100 000 inhabitants). Increase in morbidity is evident since 2003 with an average annual increase of 22%. We focused on more in-depth epidemiological analysis of campylobacteriosis cases in Slovak republic in relation to the infection agens and the outbreak of disease transmission mechanism, age and gender, location and seasonality of disease.

INTRODUCTION

Over the past 20 years, there has been a major change in the epidemiology of foodborne illness. Many factors have contributed to the change, including genetic factors, host susceptiblity, new foodborne zoonoses, antibicrobial resistance, and a substantial increase in international travel and in globalization of food trade **(Logue *et al.*, 2007)**. The control of food-borne zoonoses within the European Union is a prerequisite for assuring a functional internal market and consequently represents an important item on the political agenda. Unfortunately, until recently, gaining a clear view of the current incidence of food-borne zoonoses and the prevalence of its causative agents has been frustrated by the absence of reliable monitoring and reporting systems **(Smulders *et al.*, 2008)**. The European Community system for monitoring and collection of information on zoonotic agents in foodstuffs and animals is based on the Zoonoses Directive 2003/99/EC, which obligates the European Union (EU) Member States to collect relevant and where applicable comparable data of zoonoses, zoonotic agents, antimicrobial resistance and foodborne outbreaks. The Member States (MSs) transmit to the European Commission, every year, a report covering the data collected. The European Food Safety Authority (EFSA) is assigned the tasks of examining the data collected and publishing the Community Summary Report. This Report is prepared in collaboration with the European Centre for Disease Prevention and Control (ECDC) and EFSA's Zoonoses Collaboration Centre **(Lahuerta *et al.*, 2009)**. The latest findings published by European Food Safety Authority (EFSA) regarding zoonoses in the European Union (EU) in corroborate the fact that campylobacteriosis and salmonellosis remain the most frequently reported zoonoses in the EU **(Fosse *et al.*, 2008)**. Campylobacteriosis in humans is caused by thermophilic *Campylobacter* spp. *Campylobacter* spp. are obligate microaerophiles and most of them grow optimally at 42 °C. Because of difficulties in culturing the organism, in the past, *Campylobacter* outbreaks were reported as caused by unknown agents or erroneously by other organisms, especially *Salmonella* spp. *Campylobacter* spp. do not survive well in food, and are relatively fragile and readily killed by heat treatments **(Doorduyn *et al.*, 2008)**. *Campylobacter jejuni* has the ability to survive refrigeration and freezing, which is of obvious relevance to food safety and public health. Similar to other microorganisms, *C. jejuni* isolates can produce stress proteins, which enhance the ability of the organism to survive in adverse

environments **(Palyada *et al.*, 2009)**. Thermophilic *Campylobacter* spp. are widespread in nature. The principal reservoirs are the alimentary tracts of wild and domesticated birds and mammals. They are prevalent in food animals such as poultry, cattle, pigs and sheep; in pets, including cats and dogs; in wild birds and in environmental water sources. Animals, however, rarely succumb to disease caused by these organisms. The bacteria can readily contaminate various foodstuffs, including meat, raw milk and dairy products, and less frequently fish and fishery products, mussels and fresh vegetables. Raw milk and contaminated drinking water have been causes of larger outbreaks **(Montserrat and Yuste, 2009)**. The species most commonly associated with human infection are *C. jejuni* followed by *C. coli*, and *C. lari*, but other *Campylobacter* species are also known to cause human infection **(Hofreuter *et al.*, 2006)**. Campylobacteriosis usually occur during the summer months. The infective dose of *C. jejuni* is quite low: less than 100 organisms can cause disease. The incubation period in humans averages from two to five days and involves diarrhea (sometimes bloody), fever, and abdominal cramping as well as complications such as reactive arthritis, pancreatitis, meningitis, endocarditis, and Guillain–Barré syndrome **(Yan *et al.*,2005; Ray and Bhunia, 2008; Godschalk *et al.*,2006)**. In association with analysis of temporal trends, spatial analysis is also useful to detect changes in the geographic range of zoonoses. In this context, spatial analysis can contribute to the identification of emerging epidemiological situations. In general the risk of diseases may vary in different spatial locations due to spatial variations in the distribution of susceptible populations and of risk factors. Such a spatial heterogeneity may occur on different scales and also over large geographic areas. Moreover, even within short distances, the risk of disease may be more similar in neighbouring locations than in locations further apart **(Dohoo *et al.*, 2009)**. Developed countries have used for a long time systems of surveillance of food safety problems. However, many outbreaks of food poisoning are never recognized because known pathogens are not accurately diagnosed or reported, and other causative foodborne agents are unknown and therefore unreported. This causes underestimation of foodborne disease incidences. Furthermore, industries check their products but usually do not report positive findings **(Todd,2003)**. This situation can be corrected through initiation of new and improvement of existing epidemiological monitoring programs. There is a need to institute and maintain effective surveillance and control programs, including reliable and sufficiently discriminative methods with rapid turn-around times, for providing epidemiological information on foodborne illness outbreaks and so reducing the prevalence of pathogens. This requires a collective effort by public health authorities **(Sofos, 2008)**.

The objective of our study was to analyze the changes in the epidemiology of campylobacteriosis diseases in Slovakia over the past 10 years and evaluate them in the context of epidemiological changes comparing to the EU.

MATERIAL AND METHODS

The aim of the work is to analyze the changes in the epidemiology of campylobacteriosis diseases in Slovakia over the past 10 years and evaluate them in the context of epidemiological changes comparing to the EU.

In line with the objectives the paper is focusedon:

1. Epidemiological analysis of reported cases of campylobacteriosis in the Slovak Republic for the period 2001 to 2010 in relation to the selected characters: etiological agens and an outbreak of disease transmission mechanism, age and sex, location and seasonality of infection.

2. Analysis and comparison of changes (trends) in the epidemiology of this disease in Slovakia and in the European Union.

The epidemiological analysis report is based on factual material that was obtained from the following sources:

• Scientific literature available in print and electronic form of the bibliographic database of the Slovak Agricultural Library in Nitra.

• The Epidemic Information System (EPIS) in Slovakia.

• The European Surveillance System (TESS).

• The Community Summary Report on Trends and Sources of Zoonoses and zoonotic Agents in the European Union by EFSA.

Descriptive statistics and logical-cognitive methods and one-way analysis ANOVA were used in the evaluation and statistical analysis. Results were interpreted through the P value. The effect is considered to be statistically significant, if the P value is less than the selected significance level $\alpha = 0.05$. Because of different frequencies were observed in the tested data, the Scheffe´s test of 95% level was chosen among the Post Hoc methods. Exact calculations and testing were carried out in a specialized statistical software Statgraphics. Graphic processing and summary reviews of trends comparisons of individual factors during the decade were in absolute and relative terms processed in Microsoft Excel 2007 Microsoft Office in Windows Vista.

RESULTS AND DISCUSSION

The Slovak Republic is actively involved in Early Warning Response System (EWRS) in the case of emergency epidemiological situation in the EU. The aim of the system is a rapid exchange of information on the incidence of infectious diseases and epidemics that have the potential to spread beyond countries where they start respectively. Slovak Republic cooperates in international activities in the area of foodborne diseases and zoonoses with WHO, EFSA, and also in particular the European Centre for Disease Prevention (ECDC) in Stockholm at the European level. In addition to sending data to TESS is managed as the tasks under a special program of the European Food and Waterborne Diseases (FWD). Based on the FWD program European network of special Epidemic Information System (EPIS, since 2006) for the FWD was established in Slovakia. EPIS network is involved in the solutions of so-called "urgent inquires," what is a signal of a possible threats of an international epidemics. ECDC teams distribute the data to the all member states including Slovakia. FWD monitors the surveillance of 6 priority diseases (salmonellosis, campylobacteriosis, verotoxin - *E. coli*, yersiniosis, listeriosis and shigellosis).

Only in European Union countries are affected about 350 000 people annually by zoonoses. In Slovakia with 5 424 925 inhabitants (as reported in 31.12.2009), the epidemiological situation in the incidence of zoonoses is relatively favourable, but still is necessary veryclose collaborations between human and veterinary health authorities **(Halánová *et al.*, 2010).**Campylobacteriosis (A045) have been concerned one of the leading position regarding the incidence of foodborne diseases in the last 5 years in Slovakia. This situation correlates well with other members states forward, where campylobacteriosis is one of the often foodborne disease following salmonellosis **(Brtková and Revallová, 2010).**

For the period of 2001-2010 has been reported 25 574 campylobacteriosis cases in Slovakia. Most diseases were reported in 2010 with the number 4591 (84.63 morbidity/100 000 inhabitants), what represents an increase over 2009 of 17.5%. Increase in morbidity is evident since 2003 with an average annual increase of 22% (Fig 1). Analysing the reported cases of campylobacteriosis during the decade it can be found three homogeneous groups of years with the statistical significant differences between the beginning and the end of the decade. In a significant increase in morbidity in the last 6 years is probably involved high contamination of poultry breedings, cross-contamination by the food processing and also improvement of laboratory diagnostics.
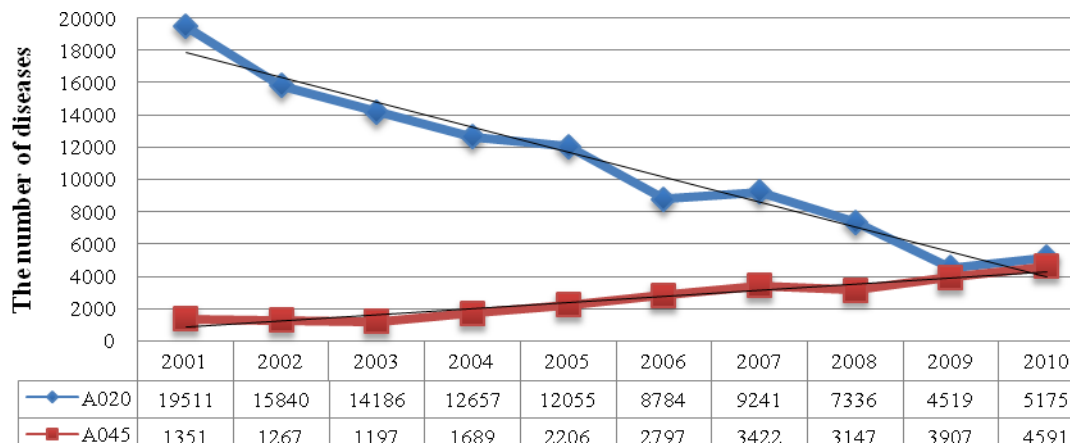
Figure 1 The trend in the total number of salmonellosis and campylobacteriosis diseases in Slovakia (2001-2010) (own processing)

Campylobacteriosis remained the most reported zoonotic disease in humans within EU, showing a slight increase with 198 252 cases in 2009 compared to 190 566 in 2008. The case fatality rate was 0.02%, which is lower than for salmonellosis. The number of reported cases during the period of 2001-2010 varies between 139 581 total cases in 2003 to 200 889 in 2007. It is interesting that 2003 both, in Slovakia and the EU was reported the lowest number of campylobacteriosisdiseases. The trend of campylobacteriosis in the EU can be considered as a lineary slightly upwarding. Monitoring and surveillance schemes for some zoonotic agents are not harmonised between MSs, and findings must, therefore, be interpreted with care. The data presented may not necessarily derive from sampling plans that are statistically designed, and may not accurately represent the national situation regarding zoonoses. Results are generally not directly comparable between MSs and sometimes not even between different years in one country. Concurrently in some year no surveillance system has been existed in some country. The total number of reported human campylobacteriosis cases in the EU is influenced by the expanding of the EU (Estonia, Latvia, Lithuania, Poland, Czech Republic, Hungary, Slovakia, Slovenia, Malta and Cyprus in 2004, Romania and Bulgaria in 2007).

The major etiologic agens in campylobacteriosis in Slovakia was *C. jejuni*, but it should be noted that the specification of the species occurred since 2006. Overview of different *Campylobacter* species is shown in Fig 2. The most common transferfactors included the lack of heat treated poultry meat and milk from milk machines.

The most commonly reported species in EU was *C. jejuni* followed by *C. coli*. The Community incidence increased, but no common trend within the MS was evident. MS

provided information on the origin (domestic vs. imported) of the infections, and the situation varied considerably between the MS. In foodstuffs, the highest proportion of *Campylobacter*-positive samples was reported for fresh broiler meat where, on average, 29.03% of samples were positive (2007-2009). *Campylobacter* was also commonly detected from live poultry, pigs and cattle **(EFSA Journal, 2011).**
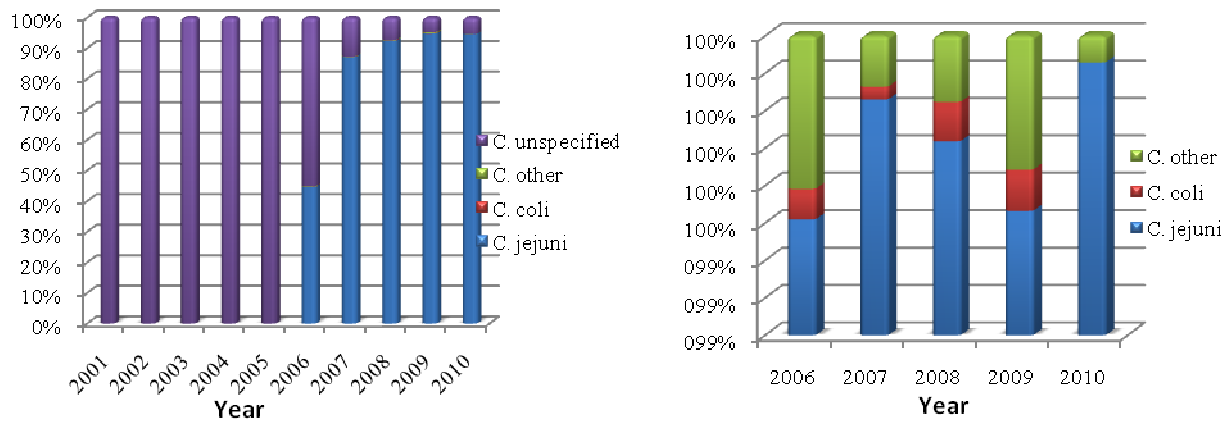

Figure 2 The overview of *Campylobacter* species (2001-2010) (own processing)

In the period of 2001-2010 13609 men and 11955 women has been reported on campylobacteriosis. The opposite trend comparing to salmonellosis can be observed. Non of these results were statistically significant if comparing men and women. Based on these, it can be assumed that slovak consumers still prefer meat dishes (especially poultry) andoften due to the insufficient heat treatment can indigestion or an infection be observed what is main cause of the infections in both sexes.

Analyses of geographical localizations of infections shows that campylobacteriosis infections were reported from each region of the Slovakia (Fig 3) during the analysed period and the highest morbidity was observed in the Bratislava region (29.09%) what significantly exceeds the morbidity of Slovak Republic. Regional disparities in Slovakia can be explained by specific eating habits, which are in relationships also with te socio-economic aspects.
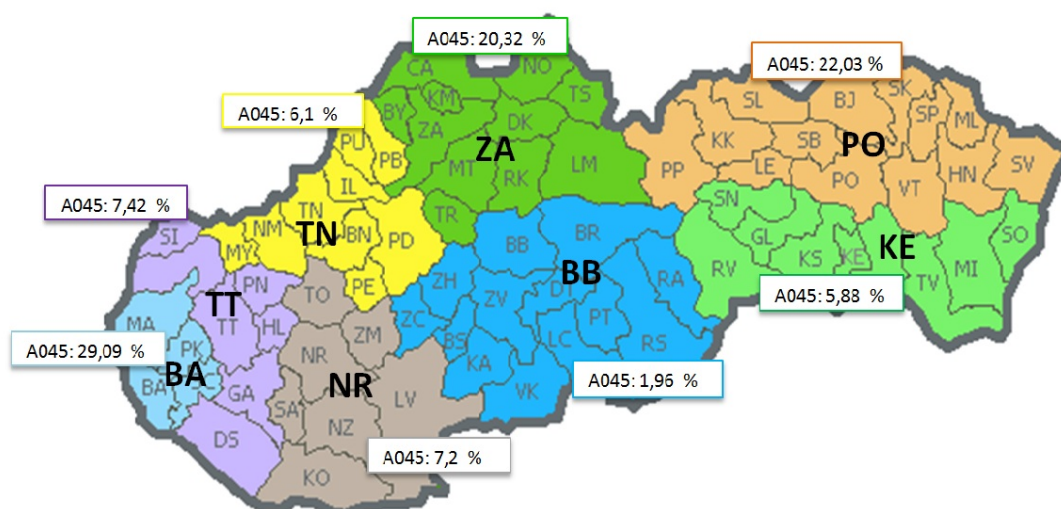
Figure 3 Regional expansion of campylobacteriosis (A045) in Slovakia (own processing)
Note. The percentages show the proportion of the number of diseases in various regions to the
total number observed in Slovakia (2001-2010).Regions: BA – Bratislava; TT – Trnava; NR
– Nitra; TN – Trenčín; BB – Banská Bystrica; KE – Košice; PO – Prešov; ZA – Žilina

Campylobacteriosis infections are reported in each age group, while the highest
number of 7431 was within the group of 1-4 year olds (age-specific morbidity 346.79/100
000) and lowest (1830 cases) for seniors over 55 years of age-specific morbidity 298.04/100
000). We also have found that the age range of 1-4 years were not statistically significantly
different from all of other categories (Tab 1).

Table 1 Verification of differences in the incidence of campylobacteriosis for the factor
Age with Scheffe´s analysis in the level of 95% (own processing)

Age	Number (2001-2010)	Average of campylobacteriosis cases	Groups homogenity	
55-64	10	84.30	X	
65+	10	98.70	X	
45-54	10	102.20	X	
35-44	10	113.80	X	
20-24	10	163.20	X	
15-19	10	196.80	X	
10-14	10	214.70	X	
25-34	10	244.00	X	
5-9	10	290.70	X	
0	10	305.70	X	
1-4	10	743.10		X

*LSD critical level: 279.932

In EU children under the age of five had the highest notification rate 120 cases per population of 100 000 in 2007 and 128 cases per 100 000 population in 2005. Other age groups varied between ca. 32 to 53 cases per population of 100 000.

Campylobacteriosis is also among the diseases with a peak incidence in the months of May to September. Its incidence varies between 55.42% (2006) to 73.42% (2004). We can say that the months of the years 2001-2010 contributed to campylobacteriosis with 62.67%. Using the Scheffe´s test, we have seen two homogeneous groups, where only the first confirmed statiscally significant differences (for the month of June to December, January, February, March and April). In a homogeneous group, other months were not with statistically significant differences (Tab 2).

Regarding the EU situation, there was a distinct seasonal variation in the human cases, with a peak in the number of cases reported during the summer months. The number of reports of human campylobacteriosis was stable over the five-year period, but the incidence was always higher during the summer months. This could be due to a seasonal effect that has not been addressed through traditional *Campylobacter* control programmes for food and animals **(Lahuerta *et al.*, 2009)**.

Table 2 Verification of differences in the incidence of campylobacteriosis for the factor Month with Scheffe´s analysis in the level of 95% (own processing)

Month	Number (2001-2010)	Average of campylobacteriosis cases	Groups homogenity	
Februar	10	93.20	X	
Januar	10	114.30	X	
December	10	122.80	X	
March	10	123.40	X	
April	10	142.50	X	
November	10	200.80	X	X
October	10	252.80	X	X
May	10	267.80	X	X
September	10	271.60	X	X
August	10	290.10	X	X
July	10	318.20	X	X
Jun	10	378.50		X

*LSD critical level: 229.218

When specific control programmes are carried out, variations in the progress of these programmes might follow a geographic pattern, leading to spatial heterogenity. However,

climate may affect maintenance and transmission of *Campylobacter* and wildlife may act as a source of infection. Under these circumstances, and considering that information on geographical location isavailable, spatial analysis can be considered as a key step in epidemiology. The objectives include generating hypotheses on the risk factors and on processes underlying the transmission of infections **(Mørkbak and Nordström, 2009)**.

CONCLUSION

The primary objective of food-borne zoonotic pathogen control is to reduce the incidence of human disease. Ideally, this is achieved by elimination of the pathogen at the most appropriate stage(s) in the food chain. Where this is not feasible the alternative is to incrementally reduce the risk at various stages of production by introducing 'hurdles', i.e. taking measures that limit growthof or partially eliminate pathogens. Obviously, the latter should be combined with consumer information on the residual risks prevailing and how to manage these. We recommend continued surveillance andongoing analysis of these trends over time. Even though the pathological consequences of campylobacteriosis and salmonellosis in most cases are relatively minor for the individual, the social costs can be high. There are direct social costs associated with zoonotic infections in terms of medical treatment and lost production due to sick leave. In addition to these direct costs, there are also indirect social costs associated with general anxiety regarding the risk of zoonotic infections.

Campylobacteriosis remained by far the most frequently reported zoonotic disease in humans. It is assumed that the observed reduction of campylobacteriosis cases is mainly attributed to successful implementation of national *Campylobacter* control programmes in fowl populations; but also other control measures along the food chain may have contributed to the reduction.

Slovakia became a part of the European Union network for surveillance of infectious diseases. Development and introduction of EPIS in Slovakia led to a strengthening of surveillance of infectious diseases, increased operational capacity of epidemiologists in the area of control of transmissible diseases, epidemics, management and control of emergency situations, speeding up and ensuring the quality o action, what is a prerequisite for rapid adoption of effective antiepidemic steps and actions for the health protection.

REFERENCES

BRTKOVÁ,A.–REVALLOVÁ,M. 2010. Contamination of animal husbandary with *Campylobacter* spp. In *Zoonozes*, 2010, p. 127-132.

DIRECTIVE 2003/99/EC of the European Parliament and of the Council of 17 November 2003 on the monitoring of zoonoses and zoonotic agents, amending Council Decision 90/424/ EEC and repealing Council Directive 92/117/EEC. Available from: http://eur-lex.europa.eu/LexUriServ/ LexUriServ.do?uri=OJ:L:2003:325:0031:0040:EN:PDF.

DOHOO, J.– MARTIN,W.– STRYHN, H. 2009. Veterinary epidemiologic research (2nd edition). Canada: AVC. 2009, p. 865.

DOORDUYN,Y.–VAN PELT,W.–SIEZEN, C.L.E.–VAN DER HORST, Y.–VAN DUYNHOVEN, T.H.P.–HOEBEE.B.–JANSSEN, R. 2008.Novel insight in the association between salmonellosis or campylobacteriosis and chronic illness, and the role of host genetics in susceptibility to these diseases.In *Epidemiology and Infection,*vol. 36, 2008, no. 9, p. 1225-1234.

EFSA Journal 2011. European Food Safety Authority (EFSA), European Centre for Disease prevention and Control (ECDC). The European Union summary report on trends and sources of zoonoses, zoonotic agents and food-borne outbreaks in 2009. Vol. 9, 2011, no. 3, 2090.

FOSSE, J.–SEEGERS, H.–MAGRAS, C. 2008. Foodborne zoonoses due to meat: a quantitative approach for a comparative risk assessment applied to pig slaughtering in Europe. In. *Vet Res.,* vol. 39:01, 2008.

GODSCHALK, P.C.R.–GILBERT, M.–JACOBS, B.C.–KRAMERS, T.–TIO-GILLEN, A.P.–ANG, C.W. 2006. Co-infection with two different *Campylobacter jejuni* strains in a patient with the Guillain–Barré syndrome. In *Microbes and Infection*, vol. 8,2006, no. 1, p. 248-253.

HALÁNOVÁ, M.–ČISLÁKOVÁ, L –STANKO, M.–SULINOVÁ, Z.–KALINOVÁ, Z.–HALÁN, M.–JARČUŠKA, P. 2010. Zoonoses – a common problem for human and veterinary medicine. In *Zoonozes*, 2010, p. 97-102.

HOFREUTER, D.–TSAI, J.–WATSON, R.–NOVIK, V.–ALTMAN, B.–BENITEZ, M.–CLARC, C.H.–PERBOST, C.–JARVIE, T.–DU, J.–GALÁN, J. 2006. Unique features of a highly pathogenic *Campylobacter jejuni* strain. In *Infect Immun.,* vol. 74, 2006, p. 4694-4707.

LAHUERTA, A.–WESTRELL, T.–TAKKINEN, J.–BOELAERT, F.–RIZZI, V.– HELWIGH, B. – BORCK, B. – KORSGAARD, H. – AMMON, A. – MÄKELÄ, P. 2009. Zoonoses in the European Union: origin, distribution and dynamics - the EFSA-ECDC summary report 2009. Euro Surveill. 2011;16(13):pii=19832 [cited 16 Sept 2011]. Available from: http://www.eurosurveillance.org/ViewArticle.

LOGUE, C.M. –NDE, C.W. 2007. *Salmonella* contamination of turkey from processing to final product--a process to product perspective. In F*oodborne Pathog Dis.*, vol. 4, 2007, no. 4, p. 491-504.

MONTSERRAT, M.M. – YUSTE, J. 2010. Emerging Bacterial Pathogens in Meat and Poultry: An Overview. In *Food and Bioprocess Technology*, vol. 3, 2010, no. 1, p. 24-35.

MØRKBAK, M.R. – NORDSTRÖM, J. 2009.The Impact of Information on Consumer Preferences for Different Animal Food Production Methods.In *Journal of Consumer Policy,* vol. 32, 2009, no. 4, p. 313-331.

PALYADA, K. – YI-QIAN, S. – FLINT, A. – BUTCHER, J. – NAIKARE, H. – STINTZI, A. 2009. Characterization of the oxidative stress stimulon and PerR regulon of *Campylobacter jejuni*. In *BMC Genomics,* vol. 10, 2009, p. 481.

RAY, B. – BHUNIA, A. 2008. Foodborne infections. Fundamental food microbiology (4th edition) Boca Raton: CRC. 2008, p. 283-313.

SMULDERS, F.J.M. – VÅGSHOLM, I. – KORKEALA, H. 2008. Food-borne zoonoses, the EU zoonosis legislation and the prospects for food safety and consumer protection during primary animal production. In *Wiener klinische Wochenschrift*, vol. 120, 2008, p. 587-598.

SOFOS, J.N. 2008. Challenges to meat safety in the 21st century. In *Meat Science*, vol. 78, 2008, no. 1-2, p. 3-13.

The Community Summary Report on Trends and Sources of Zoonoses, Zoonotic Agents and food-borne outbreaks in the European Union in 2008. The EFSA Journal (2010), 1496. [cited

13 Sept 2011]. Available from:

http://www.sva.se/upload/pdf/rapport/Zoonoses_CSR_2008.pdf

The Community Summary Report on Trends and Sources of Zoonoses, Zoonotic Agents, Antimicrobial resistance and Foodborne outbreaks in the European Union in 2005. [cited 13 Sept 2011]. Available from: http://www.efsa.europa.eu/en/efsajournal/pub/94r.htm

The Community Summary Report on Trends and Sources of Zoonoses,Zoonotic Agents, Antimicrobial Resistanceand Foodborne Outbreaksin the European Union in 2006. The EFSA Journal (2007) 130(3):352. [cited 13 Sept 2011]. Available from: http://www.efsa.europa.eu/en/efsajournal/doc/130r.pdf

The Community Summary Report on Trends and Sources of Zoonoses and Zoonotic Agents in the European Union in 2007. The EFSA Journal (2009) 223. [cited 13 Sept 2011]. Available from: http://www.fve.org/veterinary/pdf/food/efsa_zoonoses_report_2007_en.pdf

TODD, E.C.D. 2003. Microbiological safety standards and public health goals to reduce foodborne disease. In *Meat Science*, vol. 66, 2003, no. 1, p. 33-43.

YAN, S.S. – PENDRAK, M.L. – FOLEY, S.L. – POWERS, J.H. 2005. *Campylobacter* infection and Guillain–Barré syndrome: public health concerns from a microbial food safety perspective. In *Clinical and Applied Immunology Reviews*, vol. 5, 2005, no. 5, p. 285-305.