

PAPER • OPEN ACCESS

## Pork safety – challenges and opportunities

To cite this article: Nedjeljko Karabasil *et al* 2021 *IOP Conf. Ser.: Earth Environ. Sci.* **854** 012043

View the [article online](#) for updates and enhancements.

You may also like

- [Identification of pork contamination in meatball using genetic marker mitochondrial DNA cytochrome b gene by duplex-PCR](#)  
E Novianty, L R Kartikasari, J H Lee et al.
- [Construction of the Monitoring and Early Warning System of Beijing Pork Market](#)  
Jinying Yu, Xiaodong Wang and Ixin Sun
- [Study of value chains for selected foods in the Siberian Federal District](#)  
D V Parshukov, Z E Shaporova, N I Pyzhikova et al.



The Electrochemical Society  
Advancing solid state & electrochemical science & technology

## 241st ECS Meeting

May 29 – June 2, 2022 Vancouver • BC • Canada

Extended abstract submission deadline: Dec 17, 2021

Connect. Engage. Champion. Empower. Accelerate.  
**Move science forward**



**Submit your abstract**



## Pork safety – challenges and opportunities

Nedjeljko Karabasil<sup>1</sup>, Tamara Boskovic<sup>2</sup>, Dragan Vasilev<sup>1</sup>,  
Nikola Betic<sup>3</sup> and Mirjana Dimitrijevic<sup>1</sup>

<sup>1</sup> University of Belgrade, Faculty of Veterinary Medicine, Department of Food Hygiene and Technology Bulevar Oslobođenja 18, Belgrade, Republic of Serbia

<sup>2</sup> Ministry of Agriculture, Forestry and Water Management, Veterinary Directorate, Veterinary Public Health Unit, Nemanjina 22–26, Belgrade, Republic of Serbia

<sup>3</sup> Institute of Meat Hygiene and Technology, Kacanskog 13, Belgrade, Republic of Serbia

E-mail: [nedja@vet.bg.ac.rs](mailto:nedja@vet.bg.ac.rs)

**Abstract.** As pork and pork products represent an important part of the diet, the issue of pork safety and quality has become more prominent. Food safety concerns are shaping consumers' attitudes toward safe food. The farm and meat sectors aim at producing healthy animals in a protected environment, which is a key point for food/meat safety. The most common biological hazards in the pork production chain are *Salmonella* spp., *Yersinia enterocolitica*, *Trichinella* spp. and *Toxoplasma gondii*. These hazards are not detectable by conventional meat inspection, and measures rely on prevention or reduction of contamination along the production chain.

### 1. Introduction

The continuous growth of the world population has led to an increasing trend in food production, which is evident in the meat sector as well. World meat production in 2021 is forecast to expand by 2.2% (pig meat: 4.2%), to 346 million tonnes (pig meat: 114.4 million tonnes), primarily due to meat production in China – especially pig meat, with expansions in other parts of the world as well (e.g. Brazil, United States and the European Union) [1]. Meat production in Serbia reflects the primary production – the most commonly slaughtered animals are pigs and the most common type of produced and consumed meat is pork [2]. During 2019, compared to the previous year, in general, there was an increase in livestock units by 0.8%, while meat production, according to the reports on livestock slaughter in slaughterhouses, decreased by 0.1% [3]. As pork and pork products represent an important part of the diet, especially in some regions in Serbia, in the last decades, the issue of pork safety and quality has become more prominent.

### 2. Pork, key hazards and safety

Food safety is the foundation of consumer confidence, and therefore, food safety concern is shaping consumers' attitude toward safe food [4]. As from 2009, legislation on the hygiene of foodstuffs, general and specific rules on food hygiene that are mostly in line with the EU “hygiene package” [5-8], become mandatory in Serbia, and food business operators now take full responsibility for the safety of the products they place on the market [9, 10]. There are changes in primary and meat sector systems with the One Health approach, aiming at producing healthy animals in a protected environment and with the emphasis on animal welfare issues [11]. Different farm and husbandry systems (large, medium, small,



backyard) are connected with specific hazards, biological and/or chemical, which are transmitted to the next step in the meat production chain [12], and the next step in the production chain could be the source of contamination as well.

In developed parts of the world, classical zoonoses, such as tuberculosis, trichinellosis and/or cysticercosis, have become much less frequent and less important due to the appropriate preventive measures and control systems focused on them [13]. Nowadays, emerging biological hazards such as *Salmonella* and/or *Yersinia*, carried by the animals without symptoms, are an additional burden on the farm and meat sector, requiring risk-based control measures and mitigation options. In the EU, the primary sector and healthy animals are the key points for food safety, and there are recommended risk-based meat inspections [11]. Mandatory palpation and incision of slaughtered pigs should be avoided to minimise cross-contamination of meat if pigs originate from well-established, integrated farm systems. Depending on the information provided in the food chain information, if there is a need, the official veterinarian decides on additional *post-mortem* inspection. Food chain information should enable a forwards and backwards flow of information on health hazards between different food sectors [11, 14]. In Serbia, reporting procedures for food chain information that contains accurate data from the primary sector could be improved if an easy-to follow guide for farmers was prepared and distributed.

The most common biological hazards connected to pork as a source and vector are *Salmonella* spp., *Yersinia enterocolitica*, *Trichinella* spp., and *Toxoplasma gondii*. These hazards are not detectable by conventional meat inspection, and control measures rely on prevention or reduction of faecal and other contamination, from farm, transport, slaughterhouse environment to carcass and meat during slaughtering operations [15, 16]. The measures are assured by implementing good manufacturing practise, good hygienic practice and hazard analysis and critical control points in all phases of meat production [15, 16]. Meat inspection should be focused to prevent and mitigate those biological hazards, with the primary production sector having a key role in managing these risks [17, 18].

*Salmonella* is a well-known pathogen and contaminant in the pig/pork production chain. After poultry and eggs, pigs/pork are an important source and vector in human salmonellosis. In the EU, the most commonly reported zoonoses in humans were campylobacteriosis and salmonellosis, respectively [19]. Salmonellosis is the most prevalent intestinal disease in Serbia (in total, 1260 cases in 2019) and was registered almost twice as often as campylobacteriosis [20]. The incidence of salmonellosis in Serbia was 18.14 per 100,000 inhabitants, and there has been a mild decrease in the incidence in the last decade. *Salmonella* can enter the food chain in any stage of production, from the farm, transport, lairage, slaughterhouse, distribution, market, consumer, etc. [18, 21, 22]. For effective control and mitigation, the entire food chain should be involved and have an integrated approach [18]. As reported in one study [23], *Salmonella* was isolated from 23.5% of swab samples (pig carcass) after stunning, and this suggested the possibility that many pigs had become contaminated during transport, in lairage, on the slaughter line etc. In this study, the most frequently isolated serotypes were *S. Derby*, *S. Infantis* and *S. Typhimurium*. Although the occurrence of *Salmonella* on pig carcasses after processing is different from country to country, a significantly lower number of carcasses were positive for *Salmonella* after processing (e.g. scalding, chilling etc.), indicating the importance of using good hygiene and manufacturing practices on the slaughter line [23, 24].

According to an EU report, human yersiniosis is the fourth most common foodborne zoonosis, usually transmitted by raw or undercooked food, mainly pork, and water [19]. Domestic pigs are the most important sources of *Y. enterocolitica*, with a higher prevalence in conventional intensive farming in fattening pigs and which could have a seasonal occurrence [13, 25, 26]. Pathogen prevalence is better controlled in farming systems with high biosecurity levels [13]. During 2019, only 14 cases of human yersiniosis were registered in Serbia, with an incidence rate of 0.2 per 100,000 inhabitants, which was a decrease in the incidence rate compared to the previous year, when it was 0.28; the most prevalent pathogenic serotype is BT 4/O:3 [20, 27]. This serotype is the one most often isolated from pig tonsils on the slaughterhouse [27].

*Trichinella* infection has been never documented in pigs raised under high containment levels, and the risk of infection is mainly related to the lack of compliance with rules on the treatment of animal

waste [28]. Pigs raised outdoors are at risk of contact with potentially *Trichinella*-infected wildlife [29]. The Balkan region and Serbia have long records of human trichinellosis, and pork and pork products are the main sources of infection. According to official data, human trichinellosis in Serbia has decreased in the last decade [20]. The decrease of human trichinellosis in Serbia evidences the veterinary and public health sectors' efforts in the improvement of animal and human health through the legal framework for detection, surveillance, prevention, control and reporting of zoonoses, and the professional capacity of the competent authorities to implement and enforce standards and regulations for the control of *Trichinella* infections in animals and humans [30]. According to EU legislation, pigs raised under controlled housing conditions do not need to be tested for *Trichinella* any more [15]. In Serbia, there is a variety of farming systems, from controlled housing conditions to backyard farms (including pigs raised outdoors). Well-established and controlled farm systems could achieve *Trichinella*-free status.

*T. gondii* infection in pigs is an issue mainly in small scale farming and backyard farms [31]. Still, there is a risk to public health even if there is only a very low prevalence of parasites on large farms – a single, slaughter-weight pig produces a lot of portions of meat [32]. In 2019, 73 cases of human toxoplasmosis were reported in Serbia, with an incidence rate of 1.05 per 100,000 inhabitants, and in the last decade, there was a slight upward trend in the incidence of human toxoplasmosis [20]. According to available data, seroprevalence in pigs varies greatly, and depends on country and region [31]. Conventional meat inspection cannot detect *T. gondii*-infected pigs, and additional serological testing can only detect animals that could have been exposed to the parasite. Direct methods for *T. gondii* detection, like molecular tests and bioassays, are expensive and infeasible for daily use.

### 3. Conclusion

There are various obstacles to improving food safety. Developed countries, with high income and well-informed consumers, have constant pressures from the general public and media in the context of food safety and quality issues as well. In mid-income countries, like Serbia, there are many challenges, but consumer awareness and willingness to pay for safer food is increasing, while consumers' trust in the food they buy is a premise for the food business operators who do invest in food safety to maintain consumer confidence. The food sector is a sector with risks, so food/meat safety must be risk-based to eliminate or reduce food safety risks, with longitudinal and integrated approaches along the food chain, and continuous improvement. The goal is that “food will not cause harm to the consumer when it is prepared and/or eaten according to its intended use” [33].

### Acknowledgement

The study was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia (Contract number 451-03-9/2021-14/200143).

### References

- [1] FAO 2121 *Food Outlook – Biannual Report on Global Food Markets* (Rome: FAO) Available at <http://www.fao.org/3/cb4479en/cb4479en.pdf>
- [2] Karabasil N, Bošković T, Tomašević I, Vasilev D, Dimitrijević M, Katanić N and Antić D 2018 Production of traditional meat products in small and micro establishments in Serbia: current status and future perspectives *Acta Veterinaria-Beograd* **68** (4) 373–90
- [3] Statistical Yearbook RS 2020 Statistical Yearbook of the Republic of Serbia, Statistical Office of the Republic of Serbia Available at <https://publikacije.stat.gov.rs/G2020/Pdf/G20202053.pdf>
- [4] Huy D D and Giang T T 2020 Explaining consumers' intention for traceable pork regarding animal disease: The role of food safety concern, risk perception, trust, and habit *Int. J. Food Sci.* <https://doi.org/10.1155/2020/8831356>
- [5] Official Gazette of the Republic of Serbia, No 41/09
- [6] Official Gazette of the Republic of Serbia 2010, No. 73/2010
- [7] Official Gazette of the Republic of Serbia 2010, No. 72/2010

- [8] Official Gazette of the Republic of Serbia RS 2011, No. 25/2011
- [9] Karabasil N, Boskovic T, Dimitrijevic M, Vasilev D, Teodorovic V, Ilic N and Djordjevic V. 2015 Food hygiene – flexibility in traditional and small meat establishments. 58th Meat Industry Conference “Meat Safety and Quality: Where it goes?”, *Proc. Food Sci.* **5** 140–3
- [10] Karabasil N, Bošković T, Dimitrijević M, Vasilev D, Đorđević V, Lakićević B and Teodorović V 2017 Food safety – the roles and responsibilities of different sectors 59th International Meat Industry Conference MEATCON2017 *IOP Conf. Series: Earth and Environmental Science* **85** 20–3
- [11] Buncic S, Alban L and Blagojević B 2019 From traditional meat inspection to development of meat safety assurance programs in pig abattoirs – The European situation. *Food Control* **106** 106705 <https://doi.org/10.1016/j.foodcont.2019.06.031>
- [12] Sofos, J N 2008 Challenges to meat safety in the 21st century *Meat. Sci.* **78** 3–13
- [13] Zdolec N and Kiš M 2021 Meat safety from farm to slaughter—risk-based control of *Yersinia enterocolitica* and *Toxoplasma gondii* *Processes* **9** 815
- [14] Felina E, Jukolab E, Rauloc S, Heinonend J, Fredriksson-Ahomaa M 2016 Current food chain information provides insufficient information for modern meat inspection of pigs *Preventive Veterinary Medicine* **127** 113–20
- [15] Blagojevic B et al. 2021. Drivers, opportunities, and challenges of the European risk-based meat safety assurance system. *Food Control* **124** 107870
- [16] Blagojevic B and Antic D 2014 Assessment of the potential contribution of official meat inspection and abattoir process hygiene to biological safety assurance of final beef and pork carcasses. *Food Control* **36** 174–82.
- [17] EFSA, 2011 Scientific Opinion on the public health hazards to be covered by inspection of meat (swine) *EFSA J.* **9** 2351
- [18] Betić N, Branković Lazić I and Nastasijević I 2019 Biological hazards in the pork chain continuum: Risk mitigation strategy *Meat Technol.* **60** (2) 106–20
- [19] EFSA 2019 The European union one health 2018 zoonoses report 2019 *EFSA J.* **17** 1–275
- [20] IPHS 2020 *The Report on Infectious Diseases in Serbia in 2019* (Belgrade: Institute of Public Health of Serbia) p 46  
<https://www.batut.org.rs/download/izvestaji/Godisnjiizvestajzaraznimbolestima2019.pdf>
- [21] Karabasil N, Dimitrijević M, Kilibarda N, Teodorović V and Baltić M Ž 2008 Significance of *Salmonella* in pork production chain *Veterinarski glasnik*, **62** (5–6) 259–75
- [22] Karabasil N, Teodorović V, Dimitrijević M, Pavličević N, Kureljušić J, Đurić S, Sočo I and Savić-Radovanović R 2013 Behaviour of *Salmonella typhimurium* in pork minced meat and pork skin at different storage temperatures *Acta veterinaria (Beograd)* **63** (5–6) 655–63
- [23] Kureljusic J M, Dmitrić M P, Vidanović D S, Teodorović V B, Kureljušić B I, Velhner M J and Karabasil N R 2017 Prevalence of *Salmonella enterica* in slaughtered pigs in Serbia: Serotyping, PFGE-genotyping and antimicrobial resistance *J. Infect. Dev. Ctries.* **11** (08) 640–5
- [24] Karabasil N, Pavličević N, Galić N, Dimitrijević M, Lončina J, Ivanović J and Baltić M Ž 2012 *Salmonella* on pig carcasses during slaughter and processing *Veterinarski glasnik* **66** (5–6) 377–86
- [25] Laukkanen R, Martínez P O, Siekkinen K M, Ranta J, Maijala R and Korkeala H 2009 Contamination of carcasses with human pathogenic *Yersinia enterocolitica* 4/O:3 Originates from pigs infected on farms *Foodborne Pathog. Dis.* **6** 681–8
- [26] Fondrevez M, Minvielle B, Labbé A, Houdayer C, Rose N, Esnault E and Denis M 2014 Prevalence of pathogenic *Yersinia enterocolitica* in slaughter-aged pigs during a one-year survey 2010–2011 France. *Int. J. Food Microbiol.* **174** 56–62
- [27] Karabasil N, Arsić M, Galić N, Dimitrijević M, Vasilev D and Teodorović V 2016 Značaj nalaza *Yersinia enterocolitica* u mesu svinja 26 *Savetovanje veterinara Srbije* Zlatibor 8-11 septembar 2016 *Zbornik radova* 67–72

- [28] Pozio E 2019 *Trichinella* and trichinellosis in Europe *Veterinarski Glasnik* **73** (2) 65–84
- [29] Pozio E 2014 Searching for *Trichinella*: not all pigs are created equal *Trends Parasitol.* **30** 4–11
- [30] Živojinović M, Dobrosavljević I, Kulišić Z, Radojičić S, Bošković T and Plavšić B 2019 Trichinellosis in Serbia and a possibility of improvement in the control measures *Veterinarski Glasnik* **73** (2) 108–15
- [31] Klun I and Djurkovic-Djakovic O 2021 *Toxoplasma gondii* in pork & pork products – too much on our plate *Veterinarski Glasnik* **75** (1) 42–56
- [32] Dubey J P et al 2008 Endemic toxoplasmosis in pigs on a farm in Maryland: isolation and genetic characterization of *Toxoplasma gondii*. *J Parasitol.* **94** (1) 36–41
- [33] CAC/RCP 1969 General Principles of Food Hygiene Codex Alimentarius Commission 1–1969 Adopted in 1969 FAO/WHO, Codex Alimentarius International Food Standards. Amended in 1999 Revised in 1997, 2003, 2020