



Validation of novel food safety climate components and assessment of their indicators in Central and Eastern European food industry



Igor Tomasevic^{a,*}, Danijela Bursac Kovačević^b, Anet Režek Jambrak^b, Katalin Szendrő^c, Antonella Dalle Zotte^d, Mirko Prodanov^e, Bartosz Sołowiej^f, Alexandrina Sirbu^g, Jonel Subić^h, Svetlana Roljević^h, Anastasia Semenovaⁱ, Miro Kročko^j, Viera Duckova^j, Andriy Getya^k, Oksana Kravchenko^l, Ilija Djekic^a

^a University of Belgrade, Faculty of Agriculture, Nemanjina 6, 11080, Belgrade, Serbia

^b Faculty of Food Technology and Biotechnology, University of Zagreb, 10000, Zagreb, Croatia

^c Kaposvár University, Faculty of Agricultural and Environmental Science, Guba Sándor Str. 40, Kaposvár, H-7400, Hungary

^d Department of Animal Medicine, Production and Health, University of Padova, Viale dell'Università, 16, Legnaro, Padova, 35020, Italy

^e Food Institute, University "Ss. Cyril and Methodius" in Skopje, Macedonia

^f University of Life Sciences in Lublin, Faculty of Food Sciences and Biotechnology, Lublin, 20-704, Poland

^g Constantin Brancoveanu University, FMMAE Ramnicu Valcea, Romania

^h Institute of Agricultural Economics, Volgina 15, Belgrade, 11060, Serbia

ⁱ Russian Academy of Sciences, Russia

^j Slovak University of Agriculture, Faculty of Biotechnology and Food Sciences, Department of Technology and Quality of Animal Products, Tr. A. Hlinku 2, Nitra, 949 76, Slovakia

^k National University of Life and Environmental Sciences of Ukraine, Heroiv Oborony Str, 12, Kyiv, 03041, Ukraine

^l Department of Food Technology, Poltava State Agrarian Academy, 1/3 Skovorody, 36003, Ukraine

ARTICLE INFO

Keywords:

Food safety climate
Food safety culture
Knowledge
Legislation
Business priorities
Eastern Europe
Central Europe

ABSTRACT

Important insight into the Central and Eastern European food industry, beyond traditional food safety (FS) management and reflects on its food safety climate or the human route of its food safety culture is provided. Novel FS climate self-assessment tool was developed and validated by 65 FS experts from governmental agencies, third party certification bodies, food sector associations, universities and food industry. Three original FS climate components: FS knowledge, business priorities and FS legislation, were introduced and their nine components were assessed in nine Central and Eastern European countries involving 470 food companies. FS knowledge was better assessed in big and medium sized than in small companies. Knowledge component was equally assessed as good, irrespective of the FS risk profile of the food company surveyed while certified FS management system was charted by higher FS knowledge scores within a same food company. Business priorities in Central and Eastern European food organizations were related to hygiene and food safety and were always put before profit regardless of the company size. Hygiene and food safety were seen equality as a critical business success factor irrespective of the associated level of riskiness. FS climate legislation component in all food organizations surveyed was assessed affirmatively. Central and Eastern European food companies seemed to avoid problems in cooperation and trust between food safety leaders and other employees, since they have perceived FS climate highly and similarly. EU operating food companies had comparable overall FS climate to non-EU companies mostly because they have equally perceived their business priorities and appropriateness of associated FS legislation. The only exception was the FS knowledge that was better assessed in EU than non-EU food enterprises.

1. Introduction

Traditional food safety management systems (FSMS) focus on processes and are primarily based on food science. They adopt simplistic

view of behaviour change and linear cause and effect thinking while creating food safety programs like Hazard Analysis and Critical Control Points (HACCP) (Yiannas, 2009). Behaviour-based FSMS also focus on processes but they also recognize the importance of understanding and

* Corresponding author.

E-mail address: tbigor@agrif.bg.ac.rs (I. Tomasevic).

<https://doi.org/10.1016/j.foodcont.2020.107357>

Received 3 March 2020; Received in revised form 6 May 2020; Accepted 10 May 2020

Available online 16 May 2020

0956-7135/ © 2020 Elsevier Ltd. All rights reserved.

managing employee's food safety manners, attitudes and beliefs. They also heavily rely on food science expertise but also embrace the organizational culture theory and behaviour science. They acknowledge that behaviour change is complex and adopt strategic thinking while trying to create a distinctive food safety culture (FS-culture) within a food organization (Griffith Christopher, 2010).

We already know that there are evident impacts and consequences of national cultures on corporate cultures in organizations (Hofstede, 2005.; Meyer, 2014). It was also suggested that there is a relationship between national cultures and FS-culture (Nyarugwe, Linnemann, Hofstede, Fogliano, & Luning, 2016). Although food industries have taken a profound interest in the concept of FS-culture (Nyarugwe et al., 2016) this important and emerging issue has been tested in practice on a national level only and in couple of instances (De Boeck, Jaxsens, Mortier, & Vlerick, 2018.; Nyarugwe, Linnemann, & Luning, 2020.; Wiśniewska, 2019).

Despite the efforts to develop and implement FSMS, the overall food safety health burden in Europe and around the world is substantial (WHO, 2017). This burden is not evenly distributed across the European continent. The Eastern parts of Europe have the highest number of human confirmed cases combined with the number of foodborne disease outbreaks due to *Trichinella*, *Brucella* and *Yersinia* spp. (EFSA, 2018.; Mirilović et al., 2019.; Pozio, 2019). Therefore, there is the most pressing need to investigate the issue of FS-culture in Central and Eastern European food organizations. Its “techno-managerial route”, in which the FSMS and its performance are essential (De Boeck, Jaxsens, Bollaerts, & Vlerick, 2015), has already been explored in the Western Balkan countries (I. Djekic, Tomasevic, & Radovanovic, 2011. Tomašević et al., 2016. I. Tomašević et al., 2013). It's evident that it had a positive impact not only on microbiological outputs of food establishments (I. Djekic et al., 2016. N. Smigic, Djekic, Tomasevic, & Miocinovic, 2012. Tomasevic et al., 2016), but also improved the control of chemical hazards like nitrites (Tomasevic et al., 2017), sulphites (Tomasevic et al., 2018) and aflatoxin M1 (Miocinovic et al., 2017.; Tomasevic et al., 2015). Second, FS-culture “human route” was also distinguished and named “food safety culture” (FS-culture). It is commonly defined as “the relative priority or meaning of safety in an organization or work unit as perceived by employees” (De Boeck et al., 2015). Because FS-culture is an interplay of the techno-managerial and human route, both needs to be assessed when trying to make an insight into FS-culture of a food organization(s).

Therefore, this research aimed to assess overall FS-climate in Central and Eastern Europe based on a three newly developed components: knowledge, business priorities and legislation. Expert validation of FS-climate assessment tool was conducted. Relative importance between already and newly developed FS-climate components was compared. Analysis of the impact of country of origin on FS-climate in the context of the company's FS riskiness level and organizational characteristics was also performed. This investigation sought for the possible differences in FS-climate within the food companies of nine European countries based on the country of origin, food sector, size of the company, level of executed FSMS and individual FS-climate indicators. To the best of our knowledge, the results presented in this manuscript provided the first ever insight into important issue of FS-climate in Central and Eastern Europe food companies using a newly developed and validated self-assessment tool.

2. Materials and methods

2.1. Expert validation of food safety climate assessment tool

Expert validation of food safety climate assessment tool was conducted according to the method developed by De Boeck et al. (2015). Sixty five (65) experts, not involved in the development of the assessment tool, with expertise in FS and FSMS in food companies, being governmental agencies (n = 11), third party certification bodies

(n = 11), sector associations (n = 14), universities (n = 12) and food industry (n = 17) from 9 Central and Eastern European countries (Croatia 10. Hungary 5. North Macedonia 5. Poland 8. Romania 17. Russia 5. Slovakia 5. Serbia 5. Ukraine 5), were asked whether they considered the indicator and underlying assumption relevant (Yes/No), and to evaluate the importance or validity of the indicator for the assessment of the FS-climate by means of a four-point Likert scale (0 ‘not important’. 1 ‘somewhat important’. 2 ‘important’ and 3 ‘very important’). The processing of the validation results was executed according to the method used by Kirezieva et al. (2013). If 50% or less of the responding experts (n = 65) did not consider the indicator relevant, the indicator would be deleted. For the importance rating, the mean, median and interquartile range were calculated. All sixty-five (65) experts responded to the validation study (response rate: 100%).

2.2. Food safety climate assessment

Validated model of FS-climate self-assessment tool was developed with three components: knowledge, business priorities and legislation. A survey with nine statements (indicators) was created and conducted during 2019 using online platform (Slido®), directed at 470 food companies in 9 Central and Eastern European countries (Croatia, Hungary, North Macedonia, Poland, Romania, Russia, Serbia, Slovakia and Ukraine) available in local languages (Fig. 1). A purposive sampling strategy was used (Palinkas et al., 2015) required to attain a representative and qualified sample in terms of the number of employees, type of food industry, country, implemented level of FSMS and respondents' position in the company (Table 1). Company representatives had the option to rate their degree of agreement according to a five-point Likert scale from 1 ‘strongly disagree’, 2 ‘disagree’, 3 ‘no opinion’, 4 ‘agree’ to 5 ‘strongly agree’. The respondents were not informed about the topic of the survey beforehand and they were asked to fill it individually and anonymously. It took them less than 15 min to fill it out.

2.3. Statistical analysis

Likert scale data were considered as ordinal values and non-parametric statistical tests have been used since data were not normally distributed. Mann-Whitney *U* test has been performed to compare the statements between two groups-categorical variables, such as EU status of the country and position of interviewees. The Kruskal-Wallis *H* test has been carried out to compare statements between more than two groups, such as country, size of company, food sector and FSMS status. The level of statistical significance was set at 0.05. Statistical processing was performed using Microsoft Excel 2010 and SPSS Statistics 21.0.

3. Results and discussion

3.1. Food safety climate components

Several studies describe possible FS-climate components, which have already been used as a part of different self-assessment tools (Jespersen, Griffiths, & Wallace, 2017). Five already established components (leadership, communication, commitment, resources and risk awareness) are recurring in the work of Wright, Leach, and Palmer (2012), Griffith (2010a) and De Boeck et al. (2015). This is why FS-climate was even defined as “employees' (shared) perception of leadership, communication, commitment, resources and risk awareness concerning food safety and hygiene within their current work organization” (De Boeck et al., 2015). However, we believe that this definition and previously designed self-assessment tools should be extended with additional components and before all they should be food safety knowledge, business priorities and legislation.



Fig. 1. Map of Europe indicating the location of the nine countries participating in the survey.

3.2. Validation of self-assessment tool

After defining three (3) newly established FS-climate components (food safety knowledge, business priorities and legislation), three (3) indicators (statements) for each of the components were developed by the research team and based on the literature review. In total, nine (9)

indicators divided over three (3) components were acknowledged to create the questionnaire used as a self-assessment tool. Self-reported questionnaires and asking respondents to evaluate different food safety indicators by means of a Likert scale have already been used in numerous investigations (De Boeck et al., 2015.; Jevšnik, Hlebec, & Raspor, 2008. N.; Smigic, Antic, Blagojevic, Tomasevic, & Djekic,

Table 1

Expert validation results based on relevance and importance rating of the indicators in the FS-climate self-assessment tool (N = 65).

| Additional FS-culture indicators | Relevance ^a | Importance rating ^{b,c} |
|--|------------------------|----------------------------------|
| Regular refreshment training on hygiene and food safety is performed at least annually | 62 (65) | 3 (1) |
| Training on new hygiene and food safety issued is performed at least annually | 64 (65) | 3 (1) |
| We develop knowledge on hygiene and food safety issued | 64 (65) | 3 (1) |
| Knowledge | | |
| Our business priorities are related to hygiene and food safety | 62 (65) | 3 (1) |
| Hygiene and food safety are always before profit | 62 (65) | 3 (1) |
| Hygiene and food safety is seen as a critical business success factor | 60 (65) | 2 (1) |
| Business priorities | | |
| Regulations sets only minimal hygiene and food safety requirements | 60 (65) | 2 (1) |
| We are receptive to all suggestions from Local Authority Inspector | 63 (65) | 2 (1) |
| We permanently have external hygiene and food safety support | 54 (65) | 2 (1) |
| Legislation | | |

^a Number of experts considering the indicator relevant (total number of experts for the indicator).

^b Median (interquartile range) of the importance rating.

^c 0 'not important'. 1 'somewhat important'. 2 'important' and 3 'very important'.

2016).

However, before deploying the FS-climate self-assessment tool to the food organizations in Central and Eastern Europe, the tool needed to be validated by experts according to the method described by De Boeck et al. (2015). Results of the relevance evaluation and the importance scores are given in Table 1. None of the indicators was evaluated as irrelevant for the assessment of FS-climate because at least 83% of the experts recognized their importance. Since importance rating was above 2 for all the indicators proposed (scale: 0 ‘not important’ - 3 ‘very important’) the self-assessment tool should be considered valid (De Boeck et al., 2015.; Kirezjeva et al., 2013). None of the indicators was found very important to all of the 65 experts. According to the importance ratings, experts believed that the FS knowledge component was the most relevant for the FS-climate assessment tool. All the indicators for this component had a median score of 3 (very important). In terms of business priorities, their relation to hygiene and food safety and putting them before profit was deemed more important than perceiving hygiene and food safety as a critical business success factor. FS legislation component indicators, although evaluated as important, received the lowest median scores by the experts. The importance of permanently having external hygiene and food safety support within food organization was evaluated as non-important by the highest share (17%) of validators (Table 1).

We have also asked all of the 470 Central and Eastern European food companies to select one most important and one least important FS-climate indicator according to their preference. They were choosing within a group of 10 indicators. Seven (7) already established (Leadership/management. FS commitment. Employees/food handlers. Company resources. FS communication. FS risks and Food technology) and three (3) indicators we have developed and validated by food safety experts (FS knowledge. Business priorities and Legislation). Central and Eastern European food industry believed in more than a fifth of the cases (21.2%) that employees/food handlers are the most important part of the food safety puzzle (Fig. 2). Food producing organization should also provide sufficient support to their human resources in terms of necessary infrastructure, modern equipment, appropriate working places and financial resources to upkeep hygiene and FS matters (De Boeck et al., 2015). However, company resources were the most important issue only to the 2.5% of the surveyed Central and Eastern European food organizations. We argue that this result also means that

company resources are sufficient in these food subjects, at least in terms that they are not compromising food safety issues. Food safety commitment is defined as “perception of the extent of engagement and involvement concerning hygiene and food safety of all parties within the organization” (De Boeck et al., 2015). It was rated as the most important FS-climate indicator in 15.4% of the cases. Of the newly established indicators, FS knowledge seemed to have the biggest importance to Central and Eastern European food industry because 12.8% of food companies recognized it as the most important FS-climate indicator, while only 2.6% of the companies thought that knowledge was least important (Fig. 2). When FS legislation is weak and its enforcement is feeble, that limits the development of FSMS and depressingly affects FS-climate (Nanyunja et al., 2015.; Nyarugwe, Linnemann, & Luning, 2020), especially in countries with transition economies. Not surprisingly, legislation was perceived as most important FS indicator in almost one-tenth (8.1%) of Central and Eastern European food companies. FS culture of any food business can be positioned within a continuum from strongly positive, supportive and focused to one where FS priorities are overridden by other business priorities like finance (Griffith, 2010b). However, the concern about straightening business priorities, in terms of making food safety the most important factor, was shared by only 2.5% of the food subjects surveyed. More than a third (38.4%) believed that business priorities are the FS-climate indicator they should be least concerned about (Fig. 2).

3.3. Food safety climate assessment in central and Eastern Europe

3.3.1. Size and organizational characteristics of the sample

With over 300,000 companies, operating only in EU, it is almost impossible to make a truly representative sample in any kind of food industry research in terms of its size, type of food sector or demography. However, with 470 food business companies surveyed, our investigation is unprecedented in its scale. The difficulty of increasing the sample size in this type of research was already explained by De Boeck, Mortier, Jacxsens, Dequidt, and Vlerick (2017) in their FS-culture study that included two Belgian vegetable processing companies. Major drawbacks observed were limited number of companies and low response rates. Other authors carried out similar investigations in nine Zimbabwean (Nyarugwe, Linnemann, & Luning, 2020) or 136 Belgian food organizations (De Boeck et al., 2018). Even when an inter-continental analysis of food safety culture was presented (Nyarugwe, Linnemann, Ren, et al., 2020) the study was conducted in four countries and 17 participating companies.

In terms of demography of our sample, every participating country had a minimum of 30 food companies involved in the investigation (Table 2). Where possible, and according to the total number of food companies operating within the country, this number was increased accordingly. With a higher share (48.1%) of plant origin food producing companies (POFPC: fruits, beverages, drinks) than animal origin food producing companies (AOFPC: meat, dairy, poultry, fish) (36.4%) our sample was also representative in terms of the number of companies in EU food and drink industry by food sector (FoodDrinkEurope, 2019). We are aware that our sample is biased in terms of the company size, because the share of big companies is quite high (24.0%) (Table 1), especially having in mind that small and medium-sized companies represent 99.1% of food and drink industry, at least in EU terms (FoodDrinkEurope, 2019). However, this bias was created because in some of the participating countries (Croatia, Poland, Russia and Serbia) big companies were much more willing to participate compared to small and medium-sized companies.

Using purposive sampling strategy, we have avoided biasing our sample in terms of exclusive involvement of pro-active and FS oriented companies since it consisted of 15.5% non-certified and 19.6% of HACCP-only FS systems (Table 2). This bias is quite usual in this kind of investigation, e.g. research of Luning et al. (2015), Jacxsens et al. (2015) and De Boeck et al. (2018). However, our sample can be

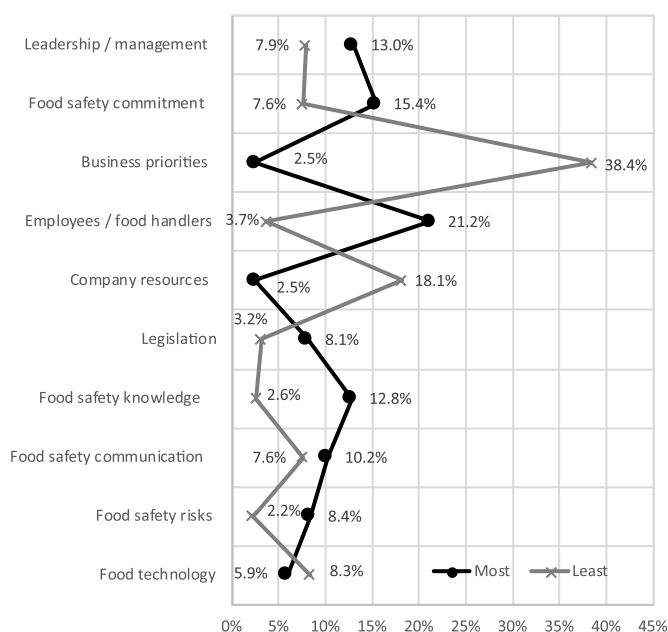


Fig. 2. Semantic differential chart of the most and least important food safety culture indicators according to respondents.

Table 2
Demographic profile and frequencies (%) of participating food companies by countries.

| | Overall (N = 470) [%] | HR (n = 52) [%] | HU (n = 30) [%] | MK (n = 30) [%] | PL (n = 31) [%] | RO (n = 116) [%] | RU (n = 32) [%] | RS (n = 56) [%] | SK (n = 66) [%] | UA (n = 57) [%] |
|---------------------------------|--------------------------|--------------------|--------------------|--------------------|--------------------|---------------------|--------------------|--------------------|--------------------|--------------------|
| Company size | | | | | | | | | | |
| Small | 188 (40.0%) | 28.8 | 40.0 | 56.7 | 25.8 | 46.5 | 15.6 | 23.2 | 56.1 | 47.4 |
| Medium | 169 (36.0%) | 30.8 | 46.7 | 33.3 | 35.5 | 44.0 | 21.9 | 28.6 | 34.8 | 36.8 |
| Big | 113 (24.0%) | 40.4 | 13.3 | 10.0 | 38.7 | 9.5 | 62.5 | 48.2 | 9.1 | 15.8 |
| Food business type | | | | | | | | | | |
| Animal origin food ^a | 171 (36.4%) | 32.7 | 36.7 | 60.0 | 32.3 | 21.6 | 56.2 | 33.9 | 28.8 | 59.6 |
| Plant origin food ^b | 226 (48.1%) | 59.6 | 46.7 | 33.3 | 54.8 | 61.2 | 34.4 | 42.9 | 51.5 | 24.6 |
| Food service ^c | 73 (15.5%) | 7.7 | 16.6 | 6.7 | 12.9 | 17.2 | 9.4 | 23.2 | 19.7 | 15.8 |
| Food safety system | | | | | | | | | | |
| Not certified | 73 (15.5%) | 5.8 | 3.3 | 10.0 | 9.6 | 12.1 | 15.6 | 10.7 | 22.7 | 40.3 |
| HACCP | 92 (19.6%) | 34.6 | 26.7 | 46.7 | 12.9 | 10.3 | 12.5 | 23.2 | 18.2 | 12.3 |
| FSMS | 305 (64.9%) | 59.6 | 70.0 | 43.3 | 77.4 | 77.6 | 71.9 | 66.1 | 59.1 | 47.4 |
| Respondents position | | | | | | | | | | |
| Management | 130 (27.7%) | 26.9 | 30.0 | 36.7 | 19.4 | 24.1 | 18.8 | 12.5 | 50.0 | 28.1 |
| Operation | 340 (72.3%) | 72.1 | 70.0 | 63.3 | 80.6 | 75.9 | 81.2 | 87.5 | 50.0 | 71.9 |

Country legend: HR – Croatia. HU – Hungary. MK – North Macedonia. PL – Poland. RO – Romania. RU – Russia. RS – Serbia. SK – Slovakia. UA – Ukraine. HACCP – Hazard Analysis and Critical Control Point. FSMS – Food safety management system (e.g. ISO 22000, BRC, IFS, GlobalGAP).

^a Animal origin food sector covers primary production and food processing of meat and poultry, fish, dairy and eggs.

^b Plant origin food sector covers primary production and food processing of fruit, vegetables and beverages.

^c Food service sector covers storage, distribution, wholesale, retail and other food services.

considered representative in terms of implemented and certified FS systems in both Central (Dzwolak, 2019) and Eastern parts of Europe (I. Tomašević et al., 2013). Unlike the study of De Boeck et al. (2018) we have also eluded biasing our results by not taking into account the FS-climate perceptions of food personnel/operators. Conveniently, our sample comprised of 27.7% managerial and 72.3% operational positions (Table 2).

3.3.2. Knowledge component

Major FSMS require that designated personnel have sufficient knowledge on two main issues – food safety (HACCP principles, hazards associated with products/processes) and good hygiene practices (BRC, 2018. IFS, 2017). Also, main barriers in implementing an effective HACCP/FSMS and root cause of nonconformities revealed in FSMS is lack of knowledge and personal training (Bas, Yuksel, & Cavusoglu, 2007. Ilija Djekic et al., 2016. I. Djekic et al., 2011). Therefore, we have adopted 'Knowledge' as an additional food safety component, deployed through three indicators. The strongest agreement with the first indicator that regular refreshment training on hygiene and food safety is performed at least annually was observed for Hungarian (4.57) and Romanian (4.45) food companies, while Ukrainian food industry (3.54) was more or less ambivalent about it (Table 3). Not surprisingly, exactly the same pattern was observed regarding the statement that training on new hygiene and food safety issued is performed at least annually (Table 3). For both indicators, period of one year was defined since all activities within implemented FSMS are planned on an annual basis (internal audits, management reviews, surveillance audits, etc). The level of agreement between all countries investigated about the last indicator and developing their own knowledge on hygiene and food safety issues was not statistically different ranging from 4.32 in Romania to 3.75 in Ukraine. A FS approach can range from “end-of-pipeline” (reactive) (as is evident in many transitioning countries) to “prevention-oriented” (proactive) approach as is within the EU (Luning et al., 2015.; Pederson & Hernández, 2014). It was also reported that operating in transitioning economies might lead to inefficient addressment of FS issues compared to non-transitioning countries (Kussaga, Jacxsens, Tiisekwa, & Luning, 2014). We argue that these factors also influenced the overall perceptions in FS knowledge between EU (4.21) and Non-EU (3.92) countries.

A number of studies already stated that the implementation of a

FSMS is much more challenging for small size food companies (Dzwolak, 2014.; Tomašević et al., 2016. I.; Tomašević et al., 2013). Barriers, which are often mentioned, are lack of resources including food safety knowledge and expertise (Faour-Klingbeil, Kuri, & Todd, 2015). Our findings are in concurrence with the before mentioned conclusions because small sized food companies in Central and Eastern Europe had a significantly lower FS knowledge score (3.94) compared to medium (4.16) and big sized companies (4.31) (Table 4).

AOFPC were classified as high-risk and POFPC as medium-risk FS companies (Jacxsens et al., 2015). Food services, including food retailers were classified as low-risk FS companies because they are perceived as contemporary drivers for FS standards (Havinga, 2013). The overall FS knowledge score in Central and Eastern European food business companies seems to be unaffected by their associated level of riskiness. Luning et al. (2011) recognized that companies with a high-risk FS profile that are more vulnerable to FS problems (AOFPC) need to be more committed and have advanced control and assurance patterns (including FS training) and when paralleled with those with a low-risk FS profile (POFPC). Our study revealed that FS-climate “knowledge” component was equally assessed as good, irrespective of the FS risk profile of the organization surveyed. There were no significant differences on how AOFPC (4.05), POFPC (4.14) or food service operators (4.13) perceived their FS knowledge. We already know that having a FSMS is no guarantee of a good FS-climate and FS performance (De Boeck et al., 2015). However, we have observed significant differences in how the FS knowledge was self-assessed between food companies with certified FSMS (4.22) and companies with only HACCP (3.98) or without FS system (4.13) (Table 4). It could be said that a higher FS knowledge is expected in companies with more elaborated FSMS because FS training and its regular refreshment are a mandatory requirement in ISO 22000, BRC, IFS and GlobalGAP standards (I. Djekic, Tomasevic, Zivkovic, & Radovanovic, 2013. I. Djekic, Tomic, et al., 2014. I. Tomašević et al., 2013).

3.3.3. Business priorities component

Many challenges lie ahead European food companies and in order to address them properly in the future they need to set a number of different and diverse priorities. They need to improve nutrition & health encouraging balanced diets and healthy lifestyles. They have to improve their environmental sustainability by tackling climate change (I.

Table 3
Additional food safety climate indicators deployed in terms of country and EU Status (N = 470).

| Additional food safety culture indicators | Mean ± SD ^a Mode ^a | EU | Non-EU | HR | HU | MK |
|--|--|---------------------------------------|---------------------------------------|----------------------------------|------------------------------------|------------------------------------|
| Regular refreshment training on hygiene and food safety is performed at least annually | 4.16 ± 0.92 4.00 | 4.29 ± 0.80 ^a 5.00 | 3.92 ± 1.05 ^b 4.00 | 4.31 ± 0.88 ^{a,b} | 4.57 ± 0.63 ^a | 3.93 ± 0.78 ^{a,b,c} |
| Training on new hygiene and food safety issued is performed at least annually | 4.08 ± 0.95 4.00 | 4.21 ± 0.87 ^a 5.00 | 3.87 ± 1.03 ^b 4.00 | 4.17 ± 0.86 ^{a,b} | 4.57 ± 0.63 ^a | 3.77 ± 0.90 ^{b,c} |
| We develop knowledge on hygiene and food safety issued | 4.08 ± 0.86 4.00 | 4.14 ± 0.78 4.00 | 3.98 ± 0.98 4.00 | 4.25 ± 0.65 | 4.20 ± 0.76 | 4.07 ± 0.69 |
| Knowledge | 4.11 ± 0.80 4.00 | 4.21 ± 0.71^a 4.00 | 3.92 ± 0.91^b 4.00 | 4.24 ± 0.71^{a,b} | 4.44 ± 0.58^a | 3.92 ± 0.72^{a,b,c} |
| Our business priorities are related to hygiene and food safety | 4.13 ± 0.85 4.00 | 4.11 ± 0.82 4.00 | 4.16 ± 0.90 5.00 | 4.21 ± 0.75 ^{a,b} | 4.07 ± 0.83 ^{a,b} | 4.13 ± 0.82 ^{a,b} |
| Hygiene and food safety are always before profit | 3.90 ± 1.07 4.00 | 3.98 ± 0.99 4.00 | 3.76 ± 1.18 4.00 | 3.85 ± 1.07 ^{a,b} | 3.90 ± 1.12 ^{a,b} | 4.10 ± 0.92 ^{a,b} |
| Hygiene and food safety is seen as a critical business success factor | 4.16 ± 0.88 4.00 | 4.18 ± 0.85 5.00 | 4.11 ± 0.93 4.00 | 4.12 ± 0.70 ^{a,b,c} | 4.33 ± 0.71 ^{a,b} | 4.57 ± 0.50 ^a |
| Business priorities | 4.06 ± 0.80 4.00 | 4.09 ± 0.77 4.00 | 4.01 ± 0.85 4.00 | 4.06 ± 0.76^{a,b} | 4.10 ± 0.72^{a,b} | 4.27 ± 0.58^a |
| Regulations sets only minimal hygiene and food safety requirements | 3.35 ± 1.17 4.00 | 3.31 ± 1.22 4.00 | 3.41 ± 1.09 4.00 | 3.37 ± 1.21 ^{b,c} | 2.13 ± 0.94 ^a | 3.30 ± 0.99 ^{b,c} |
| We are receptive to all suggestions from Local Authority Inspector | 4.19 ± 0.79 4.00 | 4.17 ± 0.76 4.00 | 4.22 ± 0.83 4.00 | 4.42 ± 0.61 ^{b,c} | 3.97 ± 0.93 ^b | 4.63 ± 0.49 ^c |
| We permanently have external hygiene and food safety support | 3.91 ± 0.91 4.00 | 3.95 ± 0.90 4.00 | 3.84 ± 0.93 4.00 | 4.10 ± 0.77 ^{a,b} | 4.03 ± 0.81 ^{a,b} | 4.07 ± 0.58 ^{a,b} |
| Legislation | 3.82 ± 0.68 4.00 | 3.81 ± 0.69 4.00 | 3.82 ± 0.67 4.00 | 3.96 ± 0.63^{b,c} | 3.38 ± 0.53^a | 4.00 ± 0.48^{b,c} |
| OVERALL | 3.99 ± 0.61 4.00 | 4.04 ± 0.58^a 4.00 | 3.92 ± 0.66^b 4.00 | 4.09 ± 0.52^{b,c} | 3.97 ± 0.43^{a,b,c} | 4.06 ± 0.47^{b,c} |
| Additional food safety culture indicators | PL | RO | RU | RS | SK | UA |
| Regular refreshment training on hygiene and food safety is performed at least annually | 3.94 ± 1.00 ^{a,b,c} | 4.45 ± 0.68 ^a | 3.88 ± 1.07 ^{b,c} | 4.32 ± 1.03 ^{a,b} | 4.06 ± 0.82 ^{a,b,c} | 3.54 ± 1.07 ^c |
| Training on new hygiene and food safety issued is performed at least annually | 3.45 ± 1.23 ^c | 4.43 ± 0.69 ^a | 3.97 ± 0.86 ^{a,b,c} | 4.16 ± 1.09 ^{a,b} | 4.05 ± 0.85 ^{a,b,c} | 3.58 ± 1.07 ^{b,c} |
| We develop knowledge on hygiene and food safety issued | 3.90 ± 0.98 | 4.32 ± 0.71 | 4.09 ± 0.73 | 4.11 ± 1.12 | 3.82 ± 0.80 | 3.75 ± 1.06 |
| Knowledge | 3.76 ± 0.94^{b,c} | 4.40 ± 0.58^a | 3.98 ± 0.69^{a,b,c} | 4.20 ± 0.98^{a,b} | 3.97 ± 0.68^{a,b,c} | 3.63 ± 0.96^c |
| Our business priorities are related to hygiene and food safety | 3.68 ± 1.01 ^a | 4.17 ± 0.78 ^{a,b} | 4.13 ± 0.87 ^{a,b} | 4.32 ± 0.94 ^b | 4.14 ± 0.78 ^{a,b} | 4.04 ± 0.91 ^{a,b} |
| Hygiene and food safety are always before profit | 3.39 ± 1.23 ^b | 4.23 ± 0.78 ^a | 3.88 ± 1.01 ^{a,b} | 3.68 ± 1.44 ^{a,b} | 3.95 ± 0.94 ^{a,b} | 3.60 ± 1.08 ^{a,b} |
| Hygiene and food safety is seen as a critical business success factor | 3.65 ± 1.08 ^c | 4.41 ± 0.76 ^{a,b} | 3.91 ± 1.03 ^{b,c} | 4.04 ± 1.11 ^{a,b,c} | 4.00 ± 0.91 | 4.07 ± 0.80 ^{a,b,c} |

(continued on next page)

Table 3 (continued)

| Additional food safety culture indicators | PL | RO | RU | RS | SK | UA |
|--|----------------------------|----------------------------|----------------------------|----------------------------|------------------------------|------------------------------|
| Business priorities | | | | | | |
| Regulations sets only minimal hygiene and food safety requirements | 3.57 ± 0.99 ^b | 4.27 ± 0.68 ^a | 3.97 ± 0.89 ^{a,b} | 4.01 ± 1.01 ^{a,b} | 4.03 ± 0.74 ^{a,b} | 3.90 ± 0.76 ^{a,b} |
| We are receptive to all suggestions from Local Authority Inspector | 3.23 ± 1.18 ^{b,c} | 3.81 ± 1.09 ^c | 3.34 ± 1.18 ^{b,c} | 3.48 ± 1.14 ^{b,c} | 2.97 ± 1.11 ^b | 3.44 ± 1.07 ^{b,c} |
| We permanently have external hygiene and food safety support | 3.81 ± 0.79 ^{a,b} | 4.28 ± 0.76 ^{b,c} | 3.72 ± 1.02 ^a | 4.50 ± 0.71 ^{b,c} | 4.05 ± 0.69 ^{b,c} | 4.00 ± 0.76 ^{b,c} |
| | 3.58 ± 0.92 ^{a,b} | 4.19 ± 0.85 ^b | 3.59 ± 1.01 ^{a,b} | 3.91 ± 1.08 ^{a,b} | 3.56 ± 0.95 ^{a,b} | 3.79 ± 0.86 ^{a,b} |
| Legislation | | | | | | |
| | 3.54 ± 0.70 ^{a,b} | 4.09 ± 0.65 ^c | 3.55 ± 0.82 ^{a,b} | 3.96 ± 0.72 ^{b,c} | 3.53 ± 0.63 ^{a,b} | 3.74 ± 0.56 ^{a,b,c} |
| OVERALL | 3.62 ± 0.72 ^a | 4.26 ± 0.52 ^c | 3.83 ± 0.64 ^{a,b} | 4.06 ± 0.76 ^{b,c} | 3.84 ± 0.54 ^{a,b,c} | 3.76 ± 0.63 ^{a,b} |

Country legend: HR – Croatia, HU – Hungary, MK – North Macedonia, PL – Poland, RO – Romania, RU – Russia, RS – Serbia, SK – Slovakia, UA – Ukraine.

^a The Mean values ± Standard deviations and modes were obtained from the raw data. Note: Items denoted with different letters are significantly different at the level of 5%. Likert scale: (1) “Strongly disagree”, (2) “Disagree”, (3) “No opinion”, (4) “Agree”, (5) “Strongly agree”.

Djekic, Miocinovic, Tomasevic, Smigic, & Tomic, 2014), increasing energy efficiency (I. Djekic & Tomasevic, 2016) and addressing food waste (Ilija Djekic, Miloradovic, Djekic, & Tomasevic, 2019). I. Djekic et al., 2019). It also has to increase its competitiveness by improving trade opportunities and ensuring security of supply (FoodDrinkEurope, 2019). However, European food industry must never forget that food safety and hygiene must remain, without any doubt, its number one priority.

Our investigation reveals that business priorities in Central and Eastern European food organizations are related to hygiene and food safety and are always put before profit (>4.00) regardless of the company size. Hygiene and food safety is seen equality as a critical business success factor regardless of their associated level of riskiness. Although food services scored lower business priorities marks (3.97) compared to AOFPC (4.06) and POFPC (4.09) the observed differences were not statistically significant. The underlying motivation for obtaining a certified and more elaborated FSMS may have played a role in the perception of the food business priorities and their indicators. They were best scored in food companies with certified FSMS (4.14) and significantly higher than in companies with only HACCP (3.90) or without FS system (3.91).

Nayak and Waterson (2017) identified two types of food business operators: ones prioritizing profit before hygiene and food safety and others doing the opposite. Overall, business priorities in Central and Eastern European food organizations were assessed as very good (4.06) with Romanian food establishments receiving the highest (4.27) and Polish the lowest (3.57) scores. Because scoring was based on personal perceptions or subjective judgements of individual employees, we might argue that Polish food companies made an underestimation while Romanian made an overestimation of their business priorities. No differences in business priorities perceptions were observed between EU (4.09) and Non-EU (4.01) food companies in Central and Eastern Europe.

3.3.4. Legislation component

One of the main benefits of implementing food safety management systems is to consistently provide safe food that meets applicable regulatory requirements (ISO, 2018). It is expected (and mandatory required) that companies have a system in place for updating relevant food safety legislation (BRC, 2018. IFS, 2017, Bondoc, 2016, 2016, 2016, 2016). However, our investigation revealed no significant differences in overall FS-legislation component scores between Central and Eastern European food companies with more elaborated FSMS (3.87) and the ones with only HACCP (3.74) or without a FS system in place (3.68) (Table 4). All food companies were equally receptive to all suggestions from Local Authority Inspectors regardless of their size or riskiness level. Minimal food safety requirements demand implementation of HACCP principles and prerequisite programs as outlined in the majority of food safety legislation (Nada Smigic, Rajkovic, Djekic, & Tomic, 2015). However, on average food companies from all countries surveyed were ambivalent (3.35) regarding the first FS-climate legislation indicator. The only exception were the Hungarian food operators which disagreed (2.13) with the statement. The rationale to include the FS-climate 'Regulation' component into our self-assessment tool was laid down in the study of Nayak and Waterson (2017), emphasizing that food safety culture and climate vary from country to country depending on their tradition and regulation.

Overall, FS-climate Legislation component in Central and Eastern European food organizations was assessed affirmatively (3.82) with Romanian food establishments receiving the highest (4.09) and Hungarian the lowest (3.57) scores. Although it was suggested before that the permanent need for external hygiene and food safety support is more pronounced in developing countries (Deodhar, 2003. Igor; Tomašević et al., 2013.; Violaris, Bridges, & Bridges, 2008), no differences on this issue were observed between developed EU (3.95) and developing Non-EU (3.84) food companies in our investigation.

Table 4
Additional food safety climate indicators deployed in terms of company size, food business type and type of certified food safety system (N = 470).

| Additional food safety climate indicators | Mean ± StD ^b Mode ^b | Company size | | | Food business type (%) | | | Certified food safety system | | | Position | | RMSE ^c |
|--|---|--------------------------------|--------------------------------|--------------------------------|------------------------|--------------------|--------------------|--------------------------------|--------------------------------|--------------------------------|--------------------|--------------------|-------------------|
| | | Small | Medium | Big | Animal | Plant | Service | No | HACCP | FSMS | Management | Operation | |
| Regular refreshment training on hygiene and food safety is performed at least annually | 4.16 ± 0.92 4.00 | 3.98 ± 0.92 ^a | 4.21 ± 0.95 ^b | 4.35 ± 0.83 ^b | 4.09 ± 0.95 | 4.19 ± 0.9 | 4.21 ± 0.91 | 3.77 ± 1.10 ^a | 4.02 ± 0.90 ^a | 4.29 ± 0.85 ^b | 4.14 ± 0.79 | 4.16 ± 0.97 | 0.27 |
| Training on new hygiene and food safety issued is performed at least annually | 4.08 ± 0.95 4.00 | 3.91 ± 0.93 ^a | 4.14 ± 0.97 ^b | 4.28 ± 0.91 ^b | 4.05 ± 0.94 | 4.10 ± 0.92 | 4.1 ± 1.08 | 3.77 ± 1.06 ^a | 3.93 ± 0.98 ^a | 4.20 ± 0.89 ^b | 4.05 ± 0.89 | 4.10 ± 0.97 | 0.28 |
| We develop knowledge on hygiene and food safety issued | 4.08 ± 0.86 4.00 | 3.93 ± 0.88 ^a | 4.12 ± 0.85 ^b | 4.28 ± 0.81 ^b | 4.02 ± 0.89 | 4.12 ± 0.84 | 4.08 ± 0.88 | 3.85 ± 1.05 ^a | 3.98 ± 0.90 ^{a,b} | 4.17 ± 0.79 ^b | 4.15 ± 0.76 | 4.06 ± 0.90 | 0.25 |
| Knowledge | 4.11 ± 0.80 4.00 | 3.94 ± 0.79^a | 4.16 ± 0.81^b | 4.31 ± 0.74^b | 4.05 ± 0.82 | 4.14 ± 0.76 | 4.13 ± 0.86 | 3.79 ± 0.97^a | 3.98 ± 0.80^a | 4.22 ± 0.73^b | 4.11 ± 0.69 | 4.1 ± 0.84 | 0.24 |
| Our business priorities are related to hygiene and food safety | 4.13 ± 0.85 4.00 | 4.03 ± 0.86 | 4.17 ± 0.82 | 4.23 ± 0.86 | 4.17 ± 0.83 | 4.08 ± 0.84 | 4.16 ± 0.90 | 3.99 ± 0.98 ^a | 3.98 ± 0.90 ^a | 4.21 ± 0.79 ^b | 4.26 ± 0.70 | 4.08 ± 0.89 | 0.25 |
| Hygiene and food safety are always before profit | 3.90 ± 1.07 4.00 | 3.90 ± 1.05 | 3.93 ± 1.04 | 3.84 ± 1.15 | 3.87 ± 1.11 | 3.98 ± 0.98 | 3.71 ± 1.22 | 3.81 ± 1.00 ^{a,b} | 3.71 ± 1.17 ^a | 3.98 ± 1.05 ^b | 4.05 ± 0.97 | 3.84 ± 1.10 | 0.31 |
| Hygiene and food safety is seen as a critical business success factor | 4.16 ± 0.88 4.00 | 4.12 ± 0.88 | 4.22 ± 0.83 | 4.12 ± 0.95 | 4.15 ± 0.88 | 4.20 ± 0.84 | 4.04 ± 1.02 | 3.93 ± 0.93 ^a | 4.02 ± 0.97 ^a | 4.25 ± 0.83 ^b | 4.26 ± 0.82 | 4.11 ± 0.90 | 0.26 |
| Business priorities | 4.06 ± 0.80 4.00 | 4.02 ± 0.80 | 4.11 ± 0.77 | 4.06 ± 0.86 | 4.06 ± 0.80 | 4.09 ± 0.76 | 3.97 ± 0.92 | 3.91 ± 0.79^a | 3.90 ± 0.88^a | 4.14 ± 0.77^b | 4.19 ± 0.67 | 4.01 ± 0.84 | 0.24 |
| Regulations sets only minimal hygiene and food safety requirements | 3.35 ± 1.17 4.00 | 3.39 ± 1.13 | 3.32 ± 1.21 | 3.33 ± 1.21 | 3.20 ± 1.20 | 3.38 ± 1.15 | 3.59 ± 1.15 | 3.66 ± 1.04 ^b | 3.05 ± 1.17 ^a | 3.36 ± 1.19 ^c | 3.32 ± 1.17 | 3.36 ± 1.18 | 0.35 |
| We are receptive to all suggestions from Local Authority Inspector | 4.19 ± 0.79 4.00 | 4.18 ± 0.76 | 4.21 ± 0.80 | 4.19 ± 0.82 | 4.22 ± 0.79 | 4.16 ± 0.77 | 4.21 ± 0.83 | 3.96 ± 0.86 ^a | 4.28 ± 0.76 ^b | 4.22 ± 0.77 ^b | 4.19 ± 0.76 | 4.19 ± 0.80 | 0.23 |
| We permanently have external hygiene and food safety support | 3.91 ± 0.91 4.00 | 3.84 ± 0.93 | 3.97 ± 0.86 | 3.94 ± 0.98 | 3.95 ± 0.88 | 3.87 ± 0.93 | 3.93 ± 0.96 | 3.42 ± 0.94 ^a | 3.88 ± 0.82 ^{a,b} | 4.04 ± 0.90 ^b | 3.92 ± 0.94 | 3.91 ± 0.91 | 0.27 |

(continued on next page)

Table 4 (continued)

| Additional food safety climate indicators | Mean \pm SD ^b Mode ^b | | Food business type (*) | | | | | Certified food safety system | | | | Position | | RMSE ^c |
|---|--|-----------------|------------------------|-----------------|-----------------|-----------------|------------------------------|------------------------------|------------------------------|-----------------|-----------------|----------|--|-------------------|
| | Small | Medium | Big | Animal | Plant | Service | No | HACCP | FSMS | Management | Operation | | | |
| Legislation | 3.82 \pm 0.68 4.00 | 3.83 \pm 0.64 | 3.82 \pm 0.77 | 3.79 \pm 0.70 | 3.80 \pm 0.67 | 3.91 \pm 0.72 | 3.68 \pm 0.69 | 3.74 \pm 0.66 | 3.87 \pm 0.69 | 3.81 \pm 0.66 | 3.82 \pm 0.70 | 0.22 | | |
| OVERALL | 3.99 \pm 0.61 4.00 | 4.03 \pm 0.60 | 4.06 \pm 0.64 | 3.97 \pm 0.62 | 4.01 \pm 0.59 | 4.00 \pm 0.69 | 3.79 \pm 0.68 ^a | 3.87 \pm 0.58 ^a | 4.08 \pm 0.59 ^b | 4.04 \pm 0.54 | 3.98 \pm 0.64 | 0.20 | | |

^a Animal origin food sector covers primary production and food processing of meat and poultry, fish, dairy and eggs. Plant origin food sector covers primary production and food processing of fruit, vegetables and beverages. Food service sector covers storage, distribution, wholesale, retail and other food services. HACCP – Hazard Analysis and Critical Control Point. FSMS – Food safety management system (e.g. ISO 22000, BRC, IFS, GlobalGAP).

^b The Mean values \pm Standard deviations and modes were obtained from the raw data. Note: Items denoted with different letters are significantly different at the level of 5%.

^c RMSE: root-mean-square-error Likert scale: (1) “Strongly disagree”, (2) “Disagree”, (3) “No opinion”, (4) “Agree”, (5) “Strongly agree”.

4. Conclusions

This investigation provided an important insight into the Central and Eastern European food industry, beyond the traditional FS management and reflected on the human route of its FS-culture. We have developed original FS-climate self-assessment tool with three novel components: knowledge, business priorities and legislation. The tool was successfully validated by 65 food safety experts from all nine participating countries.

Overall, FS-climate in Central and Eastern European food industry was assessed as good (3.99) with Romania leading (4.26) and Poland being at the end (3.62) of the list of countries included in this survey (Table 4). No significant overall FS-climate difference between EU (4.04) and non-EU operating (3.92) food establishments was observed. Neither company size nor riskiness level of food business operators significantly influenced their FS-climate perceptions. Third-party certification have predisposed not only FSMS design and its implementation but also the associated FS-climate perception within these companies. Companies with more elaborated FSMS agreed more (4.08) to the FS-climate indicators compared to food companies with only HACCP (3.87) or without any FS system (3.68). Both managers (4.04) and operational employees (3.98) perceived FS-climate similarly and very good within their food business companies. This might suggest that both managerial and operational levels of the companies are “on the same wavelength” (De Boeck et al., 2015) in terms of FS-climate since no meaningful perceptual differences were observed for all the nine (9) individual FS-climate indicators.

Further research is needed to unveil the (eventual) relation between the (subjective) FS-climate assessment in Central and Eastern European food companies and FS behaviour of their employees alongside (objective) measurements of their FS output.

CRedit authorship contribution statement

Igor Tomasevic: Investigation, Methodology. **Danijela Bursac Kovačević:** Investigation. **Anet Režek Jambrak:** Investigation. **Katalin Szendrő:** Investigation. **Antonella Dalle Zotte:** Investigation. **Mirko Prodanov:** Investigation, Methodology. **Alexandrina Sirbu:** Investigation. **Jonel Subić:** Investigation. **Svetlana Roljević:** Investigation. **Anastasia Semenova:** Investigation. **Miro Kročko:** Investigation. **Viera Duckova:** Investigation. **Andriy Getya:** Investigation. **Oksana Kravchenko:** Investigation. **Ilija Djekic:** Investigation, Methodology.

Declaration of competing interest

The authors declare that there is no conflict of interest.

References

- Bas, M., Yuksel, M., & Cavusoglu, T. (2007). Difficulties and barriers for the implementing of HACCP and food safety systems in food businesses in Turkey. *Food Control*, 18(2), 124–130. <https://doi.org/10.1016/j.foodcont.2005.09.002>.
- Bondoc, I. (2016). *European regulation in the veterinary sanitary and food safety area, a component of the European policies on the safety of food products and the protection of consumer interests: A 2007 retrospective. Part One: The role of European institutions in laying down and passing laws specific to the veterinary sanitary and food safety area.* Universul Juridic, Supliment12–15. Available online <http://revista.universuljuridic.ro/supliment/european-regulation-veterinary-sanitary-food-safety-area-component-european-policies-safety-food-products-protection-consumer-interests-2007-retrospective/>.
- Bondoc, I. (2016). *European regulation in the veterinary sanitary and food safety area, a component of the European policies on the safety of food products and the protection of consumer interests: A 2007 retrospective. Part Two: Regulations.* Universul juridic, supliment, Vols. 16–19. Available online <http://revista.universuljuridic.ro/supliment/european-regulation-veterinary-sanitary-food-safety-area-component-european-policies-safety-food-products-protection-consumer-interests-2007-retrospective-2/>.
- Bondoc, I. (2016). *European regulation in the veterinary sanitary and food safety area, a component of the European policies on the safety of food products and the protection of consumer interests: A 2007 retrospective. Part Three: Directives.* Universul juridic,

- supplement, Vols. 20–23. Available online <http://revista.universuljuridic.ro/supliment/european-regulation-veterinary-sanitary-food-safety-area-component-european-policies-safety-food-products-protection-consumer-interests-2007-retrospective-part/>.
- Bondoc, I. (2016). *European regulation in the veterinary sanitary and food safety area, a component of the European policies on the safety of food products and the protection of consumer interests: A 2007 retrospective. Part Four: Decisions. Universul juridic, supliment*. 24–27. Available online <http://revista.universuljuridic.ro/supliment/european-regulation-veterinary-sanitary-food-safety-area-component-european-policies-safety-food-products-protection-consumer-interests-2007-retrospective-part-2/>.
- BRC (2018). *BRC global standard for food safety, issue 8*. London, UK: BRC Trading Ltd.
- De Boeck, E., Jacxsens, L., Bollaerts, M., & Vlerick, P. (2015). Food safety climate in food processing organizations: Development and validation of a self-assessment tool. *Trends in Food Science & Technology*, 46(2), 242–251. <https://doi.org/10.1016/j.tifs.2015.09.006> Part A).
- De Boeck, E., Jacxsens, L., Mortier, A. V., & Vlerick, P. (2018). Quantitative study of food safety climate in Belgian food processing companies in view of their organizational characteristics. *Food Control*, 88, 15–27. <https://doi.org/10.1016/j.foodcont.2017.12.037>.
- De Boeck, E., Mortier, A. V., Jacxsens, L., Dequidt, L., & Vlerick, P. (2017). Towards an extended food safety culture model: Studying the moderating role of burnout and jobstress, the mediating role of food safety knowledge and motivation in the relation between food safety climate and food safety behavior. *Trends in Food Science & Technology*, 62, 202–214. <https://doi.org/10.1016/j.tifs.2017.01.004>.
- Deodhar, S. Y. (2003). Motivation for and cost of HACCP in Indian food processing industry. *Indian Journal of Economics and Business*, 2, 193–208.
- Djekic, I., Dragojlovic, S., Miloradovic, Z., Miljkovic-Zivanovic, S., Savic, M., & Kekic, V. (2016). Improving the confectionery industry supply chain through second party audits. *British Food Journal*, 118(5), 1041–1066. <https://doi.org/10.1108/BFJ-11-2015-0448>.
- Djekic, I., Kuzmanovic, J., Andelkovic, A., Saračević, M., Stojanović, M. M., & Tomašević, I. (2016). Effects of HACCP on process hygiene in different types of Serbian food establishments. *Food Control*, 60, 131–137. <https://doi.org/10.1016/j.foodcont.2015.07.028>.
- Djekic, I., Miloradovic, Z., Djekic, S., & Tomasevic, I. (2019). Household food waste in Serbia – attitudes, quantities and global warming potential. *Journal of Cleaner Production*, 222, 44–52. <https://doi.org/10.1016/j.jclepro.2019.04.400>.
- Djekic, I., Miocinovic, J., Tomasevic, I., Smigic, N., & Tomic, N. (2014). Environmental life-cycle assessment of various dairy products. *Journal of Cleaner Production*, 68, 64–72. <https://doi.org/10.1016/j.jclepro.2013.12.054>.
- Djekic, I., Operta, S., Djulancic, N., Lorenzo, J. M., Barba, F. J., Djordjević, V., et al. (2019). Quantities, environmental footprints and beliefs associated with household food waste in Bosnia and Herzegovina. *Waste Management & Research*, 37(12), 1250–1260. <https://doi.org/10.1177/0734242X19873709>.
- Djekic, I., & Tomasevic, I. (2016). Environmental impacts of the meat chain - current status and future perspectives. *Trends in Food Science & Technology*, 54, 94–102. <https://doi.org/10.1016/j.tifs.2016.06.001>.
- Djekic, I., Tomasevic, I., & Radovanovic, R. (2011). Quality and food safety issues revealed in certified food companies in three Western Balkans countries. *Food Control*, 22(11), 1736–1741. <https://doi.org/10.1016/j.foodcont.2011.04.006>.
- Djekic, I., Tomasevic, I., Zivkovic, N., & Radovanovic, R. (2013). Types of food control and application of seven basic quality tools in certified food companies in Serbia. *Quality Assurance and Safety of Crops & Foods*, 5(4), 325–332. <https://doi.org/10.3920/QAS2011.0104>.
- Djekic, I., Tomic, N., Smigic, N., Tomasevic, I., Radovanovic, R., & Rajkovic, A. (2014). Quality management effects in certified Serbian companies producing food of animal origin. *Total Quality Management and Business Excellence*, 25(3–4), 383–396. <https://doi.org/10.1080/14783363.2013.776765>.
- Dzwolow, W. (2014). HACCP in small food businesses – the Polish experience. *Food Control*, 36(1), 132–137. <https://doi.org/10.1016/j.foodcont.2013.07.043>.
- Dzwolow, W. (2019). Assessment of HACCP plans in standardized food safety management systems – the case of small-sized Polish food businesses. *Food Control*, 106, 1–16. <https://doi.org/10.1016/j.foodcont.2019.106716>.
- EFSA (2018). The European Union summary report on trends and sources of zoonoses, zoonotic agents and food-borne outbreaks in 2017. *EFSA Journal*, 16(12), e05500.
- Faour-Klingbeil, D., Kuri, V., & Todd, E. (2015). Investigating a link of two different types of food business management to the food safety knowledge, attitudes and practices of food handlers in Beirut, Lebanon. *Food Control*, 55, 166–175.
- FoodDrinkEurope (2019). Brussels: Data & Trends of the European Food and Drink Industry30 2019.
- Griffith, C. J. (2010). Food safety culture: Creating a behaviour-based food safety management system. *British Food Journal*, 112(4), 457–458. <https://doi.org/10.1108/00070701011034457>.
- Griffith, C. J. (2010a). The assessment of food safety culture. *British Food Journal*, 112(4), 439–456. <https://doi.org/10.1108/00070701011034448>.
- Griffith, C. J., Livesey, K., & Clayton, D. (2010b). Food safety culture: The evolution of an emerging risk factor? *British Food Journal*, 112(4), 426–438. <https://doi.org/10.1108/00070701011034439>.
- Havinga, T. (2013). Food retailers as drivers for food safety standards. Available at: SSRN 2331869 <https://doi.org/10.2139/ssrn.2331869>.
- Hofstede, G. (2005). *Cultures and organizations: Comparing values, behaviors, institutions, and organizations across nations*. Thousand Oaks: Sage Publications.
- IFS (2017). *IFS food*. Berlin, Germany: IFS Management GmbH version 6.1.
- ISO (2018). *ISO 22000:2018 Food safety management systems - requirements for any organization in the food chain*. Geneva, Switzerland: International Organization for Standardization.
- Jacxsens, L., Kirezieva, K., Luning, P. A., Ingelrham, J., Diricks, H., & Uyttendaele, M. (2015). Measuring microbial food safety output and comparing self-checking systems of food business operators in Belgium. *Food Control*, 49, 59–69. <https://doi.org/10.1016/j.foodcont.2013.09.004>.
- Jespersen, L., Griffiths, M., & Wallace, C. A. (2017). Comparative analysis of existing food safety culture evaluation systems. *Food Control*, 79, 371–379. <https://doi.org/10.1016/j.foodcont.2017.03.037>.
- Jevšnik, M., Hlebec, V., & Raspor, P. (2008). Food safety knowledge and practices among food handlers in Slovenia. *Food Control*, 19(12), 1107–1118. <https://doi.org/10.1016/j.foodcont.2007.11.010>.
- Kirezieva, K., Nanyunja, J., Jacxsens, L., van der Vorst, J. G. A. J., Uyttendaele, M., & Luning, P. A. (2013). Context factors affecting design and operation of food safety management systems in the fresh produce chain. *Trends in Food Science & Technology*, 32(2), 108–127. <https://doi.org/10.1016/j.tifs.2013.06.001>.
- Kussaga, J. B., Jacxsens, L., Tiisekwa, B. P., & Luning, P. A. (2014). Food safety management systems performance in african food processing companies: A review of deficiencies and possible improvement strategies. *Journal of the Science of Food and Agriculture*, 94(11), 2154–2169. <https://doi.org/10.1002/jsfa.6575>.
- Luning, P. A., Kirezieva, K., Hagelaar, G., Rovira, J., Uyttendaele, M., & Jacxsens, L. (2015). Performance assessment of food safety management systems in animal-based food companies in view of their context characteristics: A European study. *Food Control*, 49, 11–22. <https://doi.org/10.1016/j.foodcont.2013.09.009>.
- Luning, P. A., Marcelis, W. J., Rovira, J., van Boekel, M. A. J. S., Uyttendaele, M., & Jacxsens, L. (2011). A tool to diagnose context riskiness in view of food safety activities and microbiological safety output. *Trends in Food Science & Technology*, 22, 67–79. <https://doi.org/10.1016/j.tifs.2010.09.009>.
- Meyer, E. (2014). *The culture map: Breaking through the invisible boundaries of global business*. Public Affairs.
- Miocinovic, J., Keskic, T., Miloradovic, Z., Kos, A., Tomasevic, I., & Pudja, P. (2017). The aflatoxin M1 crisis in the Serbian dairy sector: The year after. *Food Additives & Contaminants Part B Surveillance*, 10(1), 1–4. <https://doi.org/10.1080/19393210.2016.1210243>.
- Mirilović, M., Tajdić, N., Vejnović, B., Đurić, S., Mirilović, N., Maris, S., et al. (2019). Distribution of Trichinella infections in pigs and Trichinellosis in humans in Serbia from 1994 to 2018. *Veterinarski Glasnik*, 73(2), 133–143. <https://doi.org/10.2298/VETGL191022024M>.
- Nanyunja, J., Jacxsens, L., Kirezieva, K., Kaaya, A. N., Uyttendaele, M., & Luning, P. A. (2015). Assessing the status of food safety management systems for fresh produce production in east africa: Evidence from certified green bean farms in Kenya and noncertified hot pepper farms in Uganda. *Journal of Food Protection*, 78(6), 1081–1089. <https://doi.org/10.4315/0362-028X.JFP-14-364>.
- Nayak, R., & Waterson, P. (2017). The Assessment of Food Safety Culture: An investigation of current challenges, barriers and future opportunities within the food industry. *Food Control*, 73, 1114–1123. <https://doi.org/10.1016/j.foodcont.2016.10.061>.
- Nyarugwe, S. P., Linnemann, A., Hofstede, G. J., Fogliano, V., & Luning, P. A. (2016). Determinants for conducting food safety culture research. *Trends in Food Science & Technology*, 56, 77–87. <https://doi.org/10.1016/j.tifs.2016.07.015>.
- Nyarugwe, S. P., Linnemann, A. R., & Luning, P. A. (2020). Prevailing food safety culture in companies operating in a transition economy - does product riskiness matter? *Food Control*, 107, 1–16. <https://doi.org/10.1016/j.foodcont.2019.106803>.
- Nyarugwe, S. P., Linnemann, A. R., Ren, Y., Bakker, E.-J., Kussaga, J. B., Watson, D., et al. (2020). An intercontinental analysis of food safety culture in view of food safety governance and national values. *Food Control*, 111, 1–16. <https://doi.org/10.1016/j.foodcont.2019.107075>.
- Palinkas, L. A., Horwitz, S. M., Green, C. A., Wisdom, J. P., Duan, N., & Hoagwood, K. (2015). Purposeful sampling for qualitative data collection and analysis in mixed method implementation research. *Administration and policy in mental health*, 42(5), 533–544. <https://doi.org/10.1007/s10488-013-0528-y>.
- Pederson, R., & Hernández, G. (2014). Food safety: State-of-play, current and future challenges. Vol. 282, 014 http://www.europarl.europa.eu/RegData/etudes/IDAN/2014/536287/IPOL_IDA.
- Pozio, E. (2019). Trichinella and trichinellosis in Europe. *Veterinarski Glasnik*, 73(2), 65–84. <https://doi.org/10.2298/VETGL190411017P>.
- Smigic, N., Antic, D., Blagojevic, B., Tomasevic, I., & Djekic, I. (2016). The level of food safety knowledge among meat handlers. *British Food Journal*, 118(1), 9–25. <https://doi.org/10.1108/BFJ-05-2015-0185>.
- Smigic, N., Djekic, I., Tomasevic, I., & Miocinovic, J. (2012). Implication of food safety measures on microbiological quality of raw and pasteurized milk. *Food Control*, 25(2), 728–731. <https://doi.org/10.1016/j.foodcont.2011.12.022>.
- Smigic, N., Rajkovic, A., Djekic, I., & Tomic, N. (2015). Legislation, standards and diagnostics as a backbone of food safety assurance in Serbia. *British Food Journal*, 117(1), 94–108. <https://doi.org/10.1108/BFJ-08-2013-0228>.
- Tomasevic, I., Dodevska, M., Simić, M., Raicevic, S., Matovic, V., & Djekic, I. (2017). The use and control of nitrites in Serbian meat industry and the influence of mandatory HACCP implementation. *Meat Science*, 134, 76–78. <https://doi.org/10.1016/j.meatsci.2017.07.020>.
- Tomasevic, I., Dodevska, M., Simić, M., Raicevic, S., Matovic, V., & Djekic, I. (2018). A decade of sulphite control in Serbian meat industry and the effect of HACCP. *Food Additives & Contaminants Part B Surveillance*, 11(1), 49–53. <https://doi.org/10.1080/19393210.2017.1403492>.
- Tomasevic, I., Kuzmanović, J., Andelković, A., Saračević, M., Stojanović, M. M., & Djekic, I. (2016). The effects of mandatory HACCP implementation on microbiological indicators of process hygiene in meat processing and retail establishments in Serbia. *Meat Science*, 114, 54–57. <https://doi.org/10.1016/j.meatsci.2015.12.008>.

- Tomasevic, I., Petrović, J., Jovetić, M., Raičević, S., Milojević, M., & Miočinović, J. (2015). Two year survey on the occurrence and seasonal variation of aflatoxin M1 in milk and milk products in Serbia. *Food Control*, 56, 64–70. <https://doi.org/10.1016/j.foodcont.2015.03.017>.
- Tomašević, I., Šmigić, N., Đekić, I., Zarić, V., Tomić, N., & Rajković, A. (2013). Serbian meat industry: A survey on food safety management systems implementation. *Food Control*, 32(1), 25–30. <https://doi.org/10.1016/j.foodcont.2012.11.046>.
- Tomašević, I., Šmigić, N., Đekić, I., Zarić, V., Tomić, N., Miocinovic, J., et al. (2016). Evaluation of food safety management systems in Serbian dairy industry. *Mljekarstvo*, 66(1), 48–58. <https://doi.org/10.15567/mljekarstvo.2016.0105>.
- Violaris, Y., Bridges, O., & Bridges, J. (2008). Small businesses – big risks: Current status and future direction of HACCP in Cyprus. *Food Control*, 19(5), 439–448. <https://doi.org/10.1016/j.foodcont.2007.05.004>.
- WHO (2017). The burden of foodborne diseases in the who european region. In H. Kruse (Ed.). Copenhagen: World Health Organization.
- Wiśniewska, M. (2019). The assessment of food safety culture in small franchise restaurant in Poland: The case study. *British Food Journal*, 121(10), 2365–2378. <https://doi.org/10.1108/BFJ-03-2019-0152>.
- Wright, M., Leach, P., & Palmer, G. (2012). *A tool to diagnose culture in food business operators*. Report from Greenstreet Berman Ltd for the FSA. GSB Ref CL2567.
- Yiannas, F. (2009). *Food safety culture : Creating a behavior-based food safety management system*. Springer.