



How do consumers perceive food safety risks? – Results from a multi-country survey

Ilija Djekic^{a,*}, Aleksandra Nikolic^b, Alen Mujcinovic^b, Marijana Blazic^c, Dora Herljevic^c, Gunjan Goel^d, Joanna Trafiałek^e, Ewa Czarniecka-Skubina^e, Raquel Guiné^f, João Carlos Gonçalves^f, Sonja Smole-Mozina^g, Ajda Kunčič^g, Zorana Miloradovic^a, Jelena Miocinovic^a, Biljana Aleksic^a, Vicente M. Gómez-López^h, Sandra Maria Osésⁱ, Sibel Ozilgen^j, Nada Smigic^a

^a Faculty of Agriculture, University of Belgrade, Belgrade, Serbia

^b Faculty of Agriculture and Food Sciences, University of Sarajevo, Sarajevo, Bosnia and Herzegovina

^c Karlovac University of Applied Sciences, Karlovac, Croatia

^d Department of Microbiology, Central University of Haryana, Mahendergarh, India

^e Institute of Human Nutrition Sciences, Warsaw University of Life Sciences, Warsaw, Poland

^f CERNAS-IPV Research Centre, Polytechnic Institute of Viseu, Viseu, Portugal

^g Biotechnical Faculty, University of Ljubljana, Ljubljana, Slovenia

^h Cátedra Alimentos para la Salud, Universidad Católica San Antonio de Murcia (UCAM), Murcia, Spain

ⁱ Department of Biotechnology and Food Science, Universidad de Burgos, Burgos, Spain

^j Faculty of Fine Arts, Yeditepe University, Istanbul, Turkey

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ABSTRACT

An online survey was distributed to consumers in nine countries in order to investigate their perceptions related to causers of food safety risks, types of food associated with food-borne illnesses and the role of actors in the food supply chain. A total of 2723 respondents have participated in the survey. Results indicated that food hygiene has been recognized as the most important issue associated with food safety risks. Consumers considered meat and meat products as well as egg and egg-based products, as types of food that pose the highest risks to consumer's health. Food processors and food inspection services play the most significant role in food supply chains. Results further revealed that country of origin has the highest influence on consumer perception, opposed to gender with the least influence. Overall, results obtained in this study confirmed the role of food hygiene as the predominant factor in ensuring food safety in the mind of consumers and that animal-originated food has been perceived as the type of food holding higher health risk opposed to food of plant origin. At the same time, these results challenge the trust in food processors and food inspection services.

1. Introduction

Global food markets have faced many food safety incidents in the past, including both microbial and chemical contaminants as vectors causing outbreaks. In year 2020, more than 3000 foodborne outbreaks, and more than 30,000 cases of illnesses have been reported in 27 countries of the European Union (EU). However, a decrease of 47% in the number of foodborne outbreaks and a decrease of 61.3% in the number of human cases compared to the previous year was mainly attributed to the Covid-19 and the withdrawal of the United Kingdom

from the EU (EFSA, 2021). For years, *Campylobacter* has been identified as the most commonly reported agent of zoonotic disease within the EU, followed by *Salmonella*. The number of outbreaks associated with *Listeria monocytogenes* infection has continuously increased over the last 4 years in the EU. Beside microbiological cause, other food safety incidents occurred in the EU, including dioxins in animal feed, mercury poisoning in fish, nitrofurans, Bovine Spongiform Encephalopathy, or ethylene oxide in sesame seeds (Fung, Wang, & Menon, 2018; Kowalska & Manning, 2022; McEvoy, 2016). In China, during a 15-year surveillance period, a total of 19,517 outbreaks were recorded with fungi, meat,

* Corresponding author. Faculty of Agriculture, University of Belgrade, Nemanjina 6, 11080, Zemun, Belgrade, Serbia.

E-mail addresses: idjekic@agrif.bg.ac.rs, idjekic@mts.rs (I. Djekic).

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vegetable, grain and aquatic products emphasized as types of food products causing them (Li et al., 2020). A similar 12-year surveillance program in India revealed grains and beans, followed by fruits, vegetables and sweets as food commodities serving as vehicles for recorded outbreaks (Bisht et al., 2021). Hence, food safety has become an issue of intense public concern, as various crises have been both frequent and repetitive.

The food safety risks are mainly associated with unexpected presence of various contaminants throughout the food supply chain (Machado Nardi, Teixeira, Ladeira, & de Oliveira Santini, 2020). The perception of food safety threats provides information related to risks associated with foods that consumers perceive as critical for their health (Redmond & Griffith, 2004; Webster, Jardine, Cash, & McMullen, 2010), and it is an important determinant in undertaking risk-reducing behavior. At the same time, it affects consumer acceptance of novel food products, food choices and purchasing patronage (Loureiro & Umberger, 2007; Tonsor, Schroeder, & Pennings, 2009). Recently, different studies have investigated food safety risks associated with the Covid-19 pandemic (Thomas & Feng, 2021) and the role of customers in risk communication (Zhu, Wen, Chu, & Sun, 2022). Consumer’s perception on food safety risks is recognized as one of the pillars that is in direct relation with the efforts towards raising awareness of different types of health-related food safety hazards (Redmond & Griffith, 2004).

It is of note that consumers’ risk perception have been investigated within one country (Erdem, Rigby, & Wossink, 2012; Van Asselt, Poortvliet, Ekkel, Kemp, & Stassen, 2018) or within several EU countries (Jacxsens et al., 2015; Krystallis et al., 2007; Van Wezemael, Verbeke, Kügler, de Barcellos, & Grunert, 2010), but no study has been performed including consumers from both EU and non-EU countries. Having in mind the above-mentioned, the aim of this study was to shed light on the perception of consumers from five EU and four non-EU countries related to three dimensions of food safety issues: i) causers of food safety risks; ii) types of food associated with food-borne incidents; and iii) the role of different actors in the food supply chain.

2. Materials and methods

2.1. Survey and questionnaire

Data used in this study were collected from nine countries in the

period from July 2021 to December 2021 using Google forms® online platform. The survey has been performed using a questionnaire developed in English language and translated to local languages using the method of back translation to ensure accuracy. The respondents were mainly recruited from existing networks of professional and family contacts and by further dissemination of the questionnaire throughout their networks. A total of 2738 respondents have participated in the survey and 2723 fully answered questionnaires were further processed. Demographic characteristics of the sample are depicted in Table 1.

A questionnaire consisting of two sections has been developed to analyze how consumers perceive food safety risks. The first section comprised of main demographic characteristics of participants including country, gender, age and education. The second section explored three dimensions of food safety risks: (i) the most/least important issues associated with food safety; (ii) types of food that pose the highest/lowest risk to consumers’ health, and (iii) the most/least important food supply chain actor responsible for food safety. Each of the three dimensions had seven pre-defined attributes developed from research of Machado Nardi et al. (2020) and Djekic et al. (2021).

2.2. Data processing

As each of the three dimensions of food safety risks had two anchors, best-worst scores method was employed by counting the number of times each attribute was chosen as most/least or highest/lowest by the respondents. Based on the results, the “S” score for each of the three dimensions has been determined. Equation for calculating the “S” score was performed in line with works of Merlino, Borra, Girgenti, Dal Vecchio, and Massaglia (2018) and Djekic et al. (2021) and is presented below.

$$S = \frac{F_B - F_W}{n} \tag{1}$$

F_B - frequency of being chosen as most/highest; F_W - frequency of being chosen as least/lowest; n – number of respondents.

In parallel, χ^2 test for association was employed to discover potential relationships in-between the three dimensions and the demographic characteristics of the sample (country, gender, age and education). The level of statistical significance was set at 0.05. Data were processed using Microsoft excel and IBM SPSS Statistics.

Table 1
Demographic characteristics per country (N = 2723).

	Overall - n (%)	BA (449)	HR (353)	IN (210)	PL (305)	PT (352)	RS (387)	SL (106)	SP (200)	TR (361)
Gender										
Male	875 (32.1%)	108 (24.1%)	99 (28%)	76 (36.2%)	134 (43.9%)	96 (27.3%)	113 (29.2%)	48 (45.3%)	54 (27%)	147 (40.7%)
Female	1830 (67.2%)	337 (75.1%)	250 (70.8%)	134 (63.8%)	171 (56.1%)	256 (72.7%)	270 (69.8%)	58 (54.7%)	145 (72.5%)	209 (57.9%)
Other	18 (0.7%)	4 (0.9%)	4 (1.1%)	0 (0%)	0 (0%)	0 (0%)	4 (1%)	0 (0%)	1 (0.5%)	5 (1.4%)
Age										
Less than 20 yrs	168 (6.2%)	1 (0.2%)	1 (0.3%)	6 (2.9%)	49 (16.1%)	7 (2%)	12 (3.1%)	7 (6.6%)	9 (4.5%)	76 (21.1%)
21–40 yrs	1222 (44.9%)	165 (36.7%)	154 (43.6%)	180 (85.7%)	84 (27.5%)	113 (32.1%)	196 (50.6%)	47 (44.3%)	110 (55%)	173 (47.9%)
41–60 yrs	849 (31.2%)	181 (40.3%)	96 (27.2%)	20 (9.5%)	65 (21.3%)	198 (56.3%)	104 (26.9%)	27 (25.5%)	70 (35%)	88 (24.4%)
Over 60 yrs of age	484 (17.8%)	102 (22.7%)	102 (28.9%)	4 (1.9%)	107 (35.1%)	34 (9.7%)	75 (19.4%)	25 (23.6%)	11 (5.5%)	24 (6.6%)
Education										
Elementary school	59 (2.2%)	0 (0%)	14 (4%)	0 (0%)	6 (2%)	1 (0.3%)	20 (5.2%)	2 (1.9%)	2 (1%)	14 (3.9%)
High school	560 (20.6%)	81 (18%)	94 (26.6%)	0 (0%)	167 (54.8%)	36 (10.2%)	100 (25.8%)	33 (31.1%)	5 (2.5%)	44 (12.2%)
College/ University	1499 (55.0%)	285 (63.5%)	215 (60.9%)	154 (73.3%)	116 (38%)	11 (3.1%)	253 (65.4%)	53 (50%)	145 (72.5%)	267 (74%)
Master/PhD degree	605 (22.2%)	83 (18.5%)	30 (8.5%)	56 (26.7%)	16 (5.2%)	304 (86.4%)	14 (3.6%)	18 (17%)	48 (24%)	36 (10%)

Legend: n represents the number of respondents; (%) represents their share in the sample.

Country codes: Bosnia and Herzegovina - BA; Croatia – HR; India – IN; Poland – PL; Portugal – PT; Serbia - RS; Slovenia – SI; Spain – SP; Turkey – TR.

3. Results and discussion

3.1. Demography of the sample

The demographic portfolio of respondents that participated in an online survey shows that 2723 questionnaires were collected from nine countries (Table 1). Female consumers (67.2%) prevailed opposed to male consumers (31.2%). Age distribution shows that 51.1% of respondents were below 40 years of age and 48.9% were older. Regarding education, over 50% of the interviewees hold a college/university degree.

3.2. Three dimensions of food safety risks

Best-worst method enables identification of influential food safety risk attributes considered by the consumers. “S” score shows the relative power of an attribute within the sample, where “0” indicates no power and scores striving to “+1.0/-1.0” show increasing/decreasing power (Wittenberg, Bharel, Bridges, Ward, & Weinreb, 2016). This method allows better judgment of participating consumers, as they only evaluate extremes, not preferences of attributes with defined levels (Marley & Louviere, 2005).

Table 2 depicts subjective priority of the three food safety dimensions among all participating consumers. Within the first dimension, it is obvious that “food hygiene” (0.544) is recognized as a most important food safety issue, opposed to “food additives” being the least important issue (−0.332) (Table 2). The fact that consumers participating in this study perceived hygiene and cleanliness as the most important food safety feature is in line with other previously published studies (Bukachi et al., 2021). Consumers recognized food hygiene as a

Table 2

Subjective priority of three food safety dimensions presented as frequency counts and standardized average score (“S”) considering the entire sample.

Issues associated with food safety risks			
Attributes	Most important	Least important	“S” average score
Food hygiene	1531	132	0.514
Food-borne bacteria	500	274	0.083
Toxins	161	74	0.032
Pesticides residues	190	227	−0.014
Residues of hormones/antibiotics	75	263	−0.069
Genetic Modified Organisms	141	724	−0.214
Food additives	125	1029	−0.332
Types of food that pose risks to consumer's health			
Attributes	Highest risk	Lowest risk	“S” average score
Meat and meat products	1008	154	0.314
Eggs and egg-based products	776	153	0.229
Milk and dairy products	509	159	0.129
Fish and fish products	270	78	0.071
Nuts	26	442	−0.153
Fresh produce (fruits/vegetables)	80	721	−0.235
Cereals and cereal products	54	1016	−0.353
Food supply chain actors responsible for food safety			
Attributes	Most important	Least important	“S” average score
Food processors	710	63	0.238
Food inspections	772	218	0.203
Primary producers	572	321	0.092
Governmental institutions	359	331	0.010
Distributors/retailers	202	264	−0.023
Other	6	210	−0.075
Food consumers	102	1316	−0.446

very important factor in food production settings (Nguyen et al., 2018), as well as in restaurants and canteens (Kim, Almanza, Ma, Park, & Kline, 2021; Liu & Lee, 2018) which is in line with the fact that food hygiene is a mandatory prerequisite program outlined in both food legislation and food safety standards (BRC, 2018; CAC, 2020; ISO, 2018). Food hygiene is equally important in households in preventing potential food-borne issues (Singh, Walia, & Farber, 2019).

Results from several studies have indicated that European consumers showed higher concerns regarding chemical risks (e.g. residues of antibiotics, hormones or pesticides) than the microbiological ones (Meagher, 2019), most probably due to the great potential for severe consequences, long-term effects and lack of personal control to prevent chemical risks. The consumers that participated in these studies have been given multiple choice to rate several food safety risks. However, when consumers that participated in our study were asked to decide on the single most important food safety risk, without ranking them, they gave the priority to “food hygiene”. For this result, no statistical difference between countries has been determined ($p > 0.05$). At the same time, the χ^2 test for association confirmed that there is statistically significant difference between countries for the least important food safety risk (Table 3, $p < 0.005$), with consumers from Bosnia and Herzegovina, Croatia, Serbia, Spain, Turkey and India selecting “food additives”, while “GMO” risk was the least important food safety risk for Polish and Slovenian consumers.

Despite the fact that several huge outbreaks occurred recently in the EU with non-animal food products (e.g. contamination of sprouted seeds with *Escherichia coli* O104:H4, contamination of frozen corn with *Listeria monocytogenes*, contamination of berries with Norovirus), (Sarno, Pezzutto, Rossi, Liebana, & Rizzi, 2021), our results showed that still the first association with high risk product is animal-originated food. Our participants have recognized “meat and meat products” as foods that pose the highest food safety risk (0.314), followed by “eggs and egg-based products” (0.299) (Table 2). This is mostly attributed to the perishable nature of animal food products, but also to numerous food safety issues related with meat products (e.g. Bovine Spongiform Encephalopathy (BSE), contamination with dioxin, and antibiotic residues) and individual perceptions of animal food products safety and health risks (Verbeke, Frewer, Scholderer, & De Brabander, 2007).

Looking into the data obtained from specific countries, our results showed that consumers from Croatia, Poland, Portugal and Spain have selected “eggs and egg-based products” as the riskiest food group (Table 3, $p < 0.005$). This is also expected, as infections caused by *Salmonella* have been considered as the largest burden of disease among all enteric diseases and salmonellosis outbreaks have often been associated with the consumption of eggs (Cardoso et al., 2021). Therefore, animal related food concerns have raised public consciousness and second thoughts about the risks related to their consumption. For most participants in this study, “cereals and cereal products” prevail as products with the lowest risks (−0.353), but also “fresh produce” (−0.235) and “nuts” (−0.153) (Table 2). As indicated previously, consumers in this study have not primarily focused their attention on chemical risks, and this is in line with their opinion that these stable products mostly associated with chemical hazards (residues of pesticides and toxins) have been rated as low risk products. This concurs with the meta-analysis on food safety risk perceptions pointing to food of animal origin as the main causer of health risk opposed to food of plant origin (Machado Nardi et al., 2020).

It is interesting that “food inspections” and “food processors” are recognized as the most important food supply chain actors, with “S” scores of 0.238 and 0.203, respectively (Table 2). Despite the fact that the current EU legislations (Regulation, 2002) emphasizes on food operators being mostly responsible for food safety, consumers from Bosnia and Herzegovina, Croatia, Serbia and India still share the opinion that “food inspections” are of utmost importance. At the same time, consumers from Portugal, Spain and Turkey share the opinion that responsibility is distributed among “food processors”, while consumers

Table 3
Most/least frequently mentioned attributes associated with all three food safety dimensions.

		Most important food safety issue	Least important food safety issue	Food type that poses highest health risk	Food type that poses lowest health risk	Most important in the food supply chain	Least important in the food supply chain
Country	BA	Food hygiene	Food additives	Meat and meat products	Nuts	Food inspections	Food consumers
	HR		Food additives	Eggs and egg-based products	Cereals and cereal products	Food inspections	
	IN		Food additives	Meat and meat products	Nuts	Food inspections	
	PL		GMO	Eggs and egg-based products	Nuts	Primary producers	
	PT		Food borne bacteria	Eggs and egg-based products	Cereals and cereal products	Food processors	
	RS		Food additives	Meat and meat products	Cereals and cereal products	Food inspections	
	SL		GMO	Meat and meat products	Cereals and cereal products	Primary producers	
	SP		Food additives	Eggs and egg-based products	Cereals and cereal products	Food processors	
	TR		Food additives	Meat and meat products	Cereals and cereal products	Food processors	
		$p > 0.05$	$\chi^2 = 896.955^b$	$\chi^2 = 1806.627^b$	$\chi^2 = 1532.126^b$	$\chi^2 = 875.520^b$	$p > 0.05$
Gender	Male	Food hygiene	Food additives	Meat and meat products	Cereals and cereal products	Food processors	Food consumers
	Female					Food inspections	
	Other					Food inspections	
		$p > 0.05$	$p > 0.05$	$p > 0.05$	$p > 0.05$	$\chi^2 = 21.913^a$	$p > 0.05$
Age	Less than 20 yrs	Food hygiene	Food additives	Meat and meat products	Cereals and cereal products	Food inspections	Food consumers
	21–40 yrs			Meat and meat products		Food inspections	
	41–60 yrs			Eggs and egg-based products		Food processors	
	Over 60 yrs of age			Eggs and egg-based products		Food inspections	
		$p > 0.05$	$p > 0.05$	$\chi^2 = 124.978^b$	$p > 0.05$	$\chi^2 = 99.412^b$	$p > 0.05$
Education	Elementary school	Food hygiene	Food additives	Eggs and egg-based products	Cereals and cereal products	Food inspections	Food consumers
	High school			Meat and meat products		Food inspections	
	College/ University Master/PhD degree			Meat and meat products		Food inspections	
		$p > 0.05$	$p > 0.05$	$\chi^2 = 47.825^b$	$p > 0.05$	$\chi^2 = 135.554^b$	$p > 0.05$

Country codes: Bosnia and Herzegovina - BA; Croatia – HR; India – IN; Poland – PL; Portugal – PT; Serbia - RS; Slovenia – SI; Spain – SP; Turkey – TR. Genetic Modified Organisms – GMO.

^a $p < 0.05$.

^b $p < 0.005$.

from Poland and Slovenia believe that “primary producers” are the most responsible (Table 3, $p < 0.005$). Similarly, the study performed in China with the aim to investigate the responsibility among pork supply chain, also confirmed that consumers are seeing food producers as the most responsible for food safety (Wu, Qiu, Lu, Zhang, & Wen, 2017). At the same time, evidence from several studies has confirmed that trust is an important factor in perceiving food safety risks, both trust in governmental institutions and food supply chain actors (Erdem et al., 2012; Machado Nardi et al., 2020; Vainio, Kaskela, Finell, Ollila, & Lundén, 2020). Consumers believe that they are the least important food actor in the chain, when it comes to food safety risks (−0.446, Table 2). For this conclusion there was no statistical difference between countries, or other demographic groups (Table 3, $p > 0.05$). This is an interesting finding as it is known that personal responsibility for food safety is in direct correlation with unsafe food preparation behavior (Lin & Roberts, 2020; Zhang, Zhu, & Bai, 2022). These results highlight the potential problems associated with food safety risks from a consumer’s perspective (Machado Nardi et al., 2020). Also, this reveals the role of cultural background and individual characteristics on perception of food safety risks, building upon conclusions raised by Machado Nardi et al. (2020).

4. Conclusion

The results identified food safety risk perception for consumers living in different countries and different regions of the world. Consumers, regardless of the country in which they live, believe that food hygiene is the most important issue associated with food safety and a prerequisite for the prevention of foodborne illnesses. Nevertheless, some differences have been induced in consumers’ perception regarding the most important actors in the food chains, which is most probably related to the cultural background and their previous experience with their national food safety legislation and inspection. In parallel, consumers are aware of potential food safety risks associated with animal origin food products, namely meat and eggs, highlighting their role in food-borne incidents. Results obtained in this study might serve as a good foundation and a starting point for public health authorities to increase compliance with responsible behaviors related to risk mitigation and to define successful food policies specific for different regions. A certain limitation of this study may be associated with different demographic characteristics between the countries.

CRediT authorship contribution statement

Ilija Djekic: Writing – original draft, Visualization, Data presentation, Formal analysis, Writing – review & editing, Investigation, Data curation. **Aleksandra Nikolic:** Investigation, Data curation. **Alen Mujcinovic:** Investigation, Data curation. **Marijana Blazic:** Investigation, Data curation. **Dora Herljevic:** Investigation, Data curation. **Gunjan Goel:** Investigation, Data curation. **Joanna Trafialek:** Investigation, Data curation. **Ewa Czarniecka-Skubina:** Investigation, Data curation. **Raquel Guiné:** Investigation, Data curation. **João Carlos Gonçalves:** Investigation, Data curation. **Sonja Smole-Mozina:** Investigation, Data curation. **Ajda Kuncic:** Investigation, Data curation. **Zorana Miloradovic:** Investigation, Data curation. **Jelena Miocinovic:** Investigation, Data curation. **Biljana Aleksic:** Investigation, Data curation. **Vicente M. Gómez-López:** Investigation, Data curation. **Sandra Maria Osés:** Investigation, Data curation. **Sibel Ozilgen:** Investigation, Data curation. **Nada Smigic:** Conceptualization, Methodology, Writing – review & editing, Supervision, Investigation, Data curation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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