JOINT ECDC-EFSA RAPID OUTBREAK ASSESSMENT

Multi-country outbreak of *Salmonella* Senftenberg ST14 infections, possibly linked to cherry-like tomatoes

27 July 2023

Abstract

Since August 2022 and as of 12 July 2023, 92 cases of *Salmonella* Senftenberg have been reported in Austria (5), Belgium (4), Czechia (4), Estonia (1), Finland (12), France (16), Germany (26), Ireland (1), the Netherlands (5), Norway (1), Sweden (11), the United Kingdom (4), and the United States (2). In total, 69.6% of the reported cases were female. One patient has died of the infection. The first case was reported in France with an isolation date of 22 August 2022 and the most recent case was reported on 24 June 2023 in Sweden. Most cases were reported between October 2022 and March 2023, with a decline in the number of countries with exposures after December. In Austria, Germany, and France, cherry-like tomatoes were identified as the food exposure most reported by interviewed cases.

The outbreak strain was detected in France from a mixed salad dish, containing cherry tomatoes and green leafy vegetables, prepared on 17 August 2022 but not served. Tomatoes from the salad in France and tomatoes in Austria were suspected as the vehicle of infections by national authorities and were traced back to wholesalers in Germany, the Netherlands and Spain, and to growers in the Netherlands, Spain and Morocco. In the absence of microbiological evidence from the tomatoes, the source of the infections could not be established.

The genetic similarity of the human outbreak strains suggests a likely common source(s) causing a prolonged, cross-border food-borne outbreak with cases intermittently reported in 11 EU/EEA countries, the UK, and the US for about 10 months. The contamination may have originated from farms growing tomatoes. Since December 2022, as the number of cases has declined, the risk of new infections has decreased to a low level.

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Event background

On 12 February 2023, **Germany** reported 10 cases of *Salmonella* Senftenberg infection in the European Surveillance portal for Infectious Diseases (EpiPulse, 2023-FWD-00009) between calendar weeks 44/2022 and 2/2023. Several countries subsequently reported cases between August 2022 and early March 2023 belonging to the same genetically defined cluster. This pointed to a common source(s) of infection for human cases and triggered the initiation of a Notification Summary by the European Centre for Disease Prevention and Control (ECDC) on 16 March 2023. The Notification Summary, with a risk assessment, was distributed to the European Commission's Directorate General for Health and Food Safety (DG SANTE) for posting in the Early Warning and Response System (EWRS) and to the food safety (Rapid Alert System for Food and Feed) and public health (European Food- and Waterborne Diseases and zoonoses network) networks on 30 March 2023.

New cases continued to be reported in March–April 2023 and on 26 April 2023, public health authorities in **France** (Santé publique France) were informed by the national food reference laboratory (Laboratoire National de Référence) that *S.* Senftenberg ST14 had been isolated from a mixed salad, which was prepared on 17 August 2022. This new microbiological evidence in food resulted in traceback investigations and, as new cases continued to be reported, ECDC and the European Food Safety Authority (EFSA) decided to upgrade the Notification Summary to a Joint Notification Summary, which was distributed to the Member States and EU-level risk managers on 26 May 2023. As further new cases have been reported, ECDC and EFSA decided to publish this multi-country food-borne outbreak as a Rapid Outbreak Assessment.

S. Senftenberg is a relatively uncommon serotype in human cases of salmonellosis; between 2007 and 2021, a total of 2 174 human cases of *S.* Senftenberg were reported, ranking the serotype 48th out of 1 210 serotypes reported to ECDC (Annex). During the period 2007–2021, the average annual number of cases was 145. In 2020 and 2021, 36 and 75 cases respectively were reported to ECDC.

Outbreak strain characterisation

The representative German outbreak strain is characterised as follows:

- *Salmonella* serotype Senftenberg, sequence type (ST) 14, SeqSphere complex type (CT) 17028.
- The EnteroBase core genome multilocus sequence typing (cgMLST) hierarchical cluster designation for the outbreak isolates is HC5_325504 [1,2].
- The genome of the representative German isolate is available in EnteroBase: 23-00207 (SAL_QB9631AA).
- Predicted antimicrobial resistance determinants (*qnr*B19) against ciprofloxacin were detected in the Austrian, French, German, Irish, Norwegian, and Swedish isolates. Phenotypic resistance to ciprofloxacin was also confirmed in the Austrian (MIC 0.38 µg/ml) and German (MIC 0.25 µg/ml) strains.

European outbreak case definition

The European outbreak case definition is as follows:

A confirmed outbreak case

- A laboratory-confirmed *Salmonella* Senftenberg ST14 case with disease onset on or after 1 June 2022 (date of sampling or date of receipt by the laboratory if date of onset is not available).

AND

- Fulfilling at least one of the following laboratory criteria:
  - within five cg-allelic differences (AD) from at least one of the representative German outbreak strains in the national cgMLST pipeline, OR
  - clustering within six cg-allelic differences in a single linkage analysis in a centralised whole genome sequencing (WGS) analysis, OR
  - belonging to the cgMLST HC5_325504 hierarchical cluster by EnteroBase scheme, OR
  - clustering according to a national single-nucleotide polymorphism (SNP) pipeline within five SNPs of the German outbreak strain, OR
  - belonging to a 5-SNP single linkage cluster with SNP designation 1.1.4.204.227.230.% according to the pipeline in the United Kingdom Health Security Agency (UKHSA) [3].

A possible outbreak case

- A laboratory-confirmed *S.* Senftenberg case with symptom onset on or after 1 June 2022 (date of sampling or date of receipt by the reference laboratory if date of onset was not available) without molecular typing data.

  AND

- No or unknown history of travel outside of the EU/EEA seven days prior to onset of symptoms.

Epidemiological and microbiological investigations of human cases

As of 12 July 2023, 92 cases (81 confirmed and 11 possible) of *S.* Senftenberg have been reported in 11 EU/EEA countries, the United Kingdom (UK), and the United States (US) since August 2022 (Table 1, Figure 1). At least 12 cases were hospitalised in Germany (10), Ireland (1), and the UK (1). One patient in Germany has died of *S.* Senftenberg infection. Of 44 cases with information on sample material available, 15 cases (34.1%) had *S.* Senftenberg isolated from urine. Isolation from one case was via abdominal fluid.

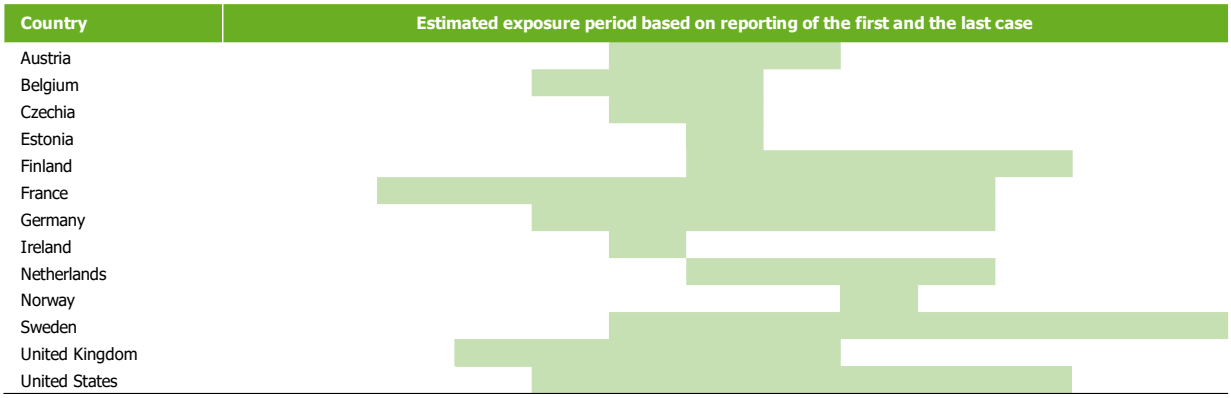
The first cases were reported in France in August 2022 and the most recent case was reported in Sweden in June 2023 (Figure 1). When looking at the number of countries by month within an estimated exposure time range, based on the first and last case reported in the country, the time period during which there appears to have been wide exposure to a suspected vehicle across countries was October 2022 to March 2023. The geographical area of exposure in terms of number of countries peaked in December 2022 in the EU/EEA (Figure 1). There is a clear predominance of women with a female-to-male ratio of 2.3:1 ($p < 0.001$, chi-square).

Table 1. Demographic and background information for 92 human *S.* Senftenberg cases in 11 EU/EEA countries, the UK and the US, as of 12 July 2023

Country	Total	Confirmed cases	Possible cases	Age range (median) or age group*	Gender	
					M	F
Austria	5	5	0	15–86 (27)	0	5
Belgium	4	4	0	33–61	0	4
Czechia	4	0	4	34–75 (38)	1	3
Estonia	1	0	1	15–24*	1	0
Finland	12	11	1	15–98	0	12
France	16	16	0	1–92 (57)	7	9
Germany	26	21	5	1–96 (68)	8	18
Ireland	1	1	0	45–64*	1	0
Netherlands	5	5	0	20–70+	2	3
Norway	1	1	0	50–60*	0	1
Sweden	11	11	0	20–91 (73)	4	7
Total EU/EEA	**86**	**75**	**11**		**25**	**61**
United Kingdom	4	4	0	2–84 (46)	2	2
United States	2	2	0	42–47 (45)	1	1
Total	**92**	**81**	**11**		**28**	**64**

** When a single case is reported per country, age group for this case is also reported.*

Figure 1. Temporal description of estimated exposure period for *S.* Senftenberg cases reported by country and month, June 2022–June 2023, as of 12 July 2023



	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22	Nov-22	Dec-22	Jan-23	Feb-23	Mar-23	Apr-23	May-23	Jun-23
Number of countries within the estimated exposure period	0	0	1	2	5	9	11	8	7	6	3	1	1

The information below was reported from public health authorities in the countries affected.

Austria reported **five** female cases of *S.* Senftenberg infection, with isolates having 0–3 ADs from the German reference strain. Cases had an age range of 15–86 years and originated from four different provinces. Disease onset dates were between mid-November 2022 and mid-January 2023. No travel was reported. All five strains belonged to ST14 and CT17028 and were resistant to ciprofloxacin (Minimum Inhibitory Concentration (MIC) 0.38 µg/ml; ResFinder gene detection – *qnr*B19).

Belgium reported **four** cases of *S.* Senftenberg infections with 0 AD from the German reference strain and disease onsets between October and December 2022. All cases were female, with an age range of 33–61 years.

Czechia reported **four** possible cases with *S.* Senftenberg infection (three females and one male) between November and December 2022, one each in weeks 44, 45, 46 and 48. Cases have an age range of 34–75 years and originate from three different regions of Czechia. Two cases were interviewed: both reported no travel, one reported consuming home-produced eggs. No other risk factors were identified. WGS was not performed.

Estonia reported **one** (possible) sporadic domestic case with *S.* Senftenberg infection in a male (15–24 years) and with sampling date 29 December 2022. WGS was not performed.

Finland reported **12** cases (11 confirmed and one possible) of *S.* Senftenberg between 12 December 2022 and 4 April 2023. In six of 11 cases, *Salmonella* was detected in urine. All cases were female and aged between 15–98 years. All cases with urinary tract infection (UTI) were in the age range 15–89 years. All six cases with known travel history reported no travel prior to illness. Travel history for the remaining cases was unknown.

France reported **16** cases with isolates matching the German reference strain (≤ 4 AD), sharing the same HC5_325504 (EnteroBase HierCC-cgMSLT scheme), with isolation dates between 22 August 2022 and 2 March 2023. Cases included nine females and seven males, aged between one and 92 years (median 57 years). The strains carried *qnr*B19 encoding for quinolone resistance. Among 16 isolates, two were detected in urine samples. Of the 16 cases, five cases were interviewed with symptom onset dates between mid-November 2022 and end of January 2023. One case had travelled to Thailand before becoming ill. One case was from northern Europe. No hospitalisations were reported among the five cases interviewed.

Germany reported **26** cases (21 confirmed and five possible) and one related death. Cases originated in multiple (12) federal states in Germany. Cases occurred between calendar weeks 44/2022 and 12/2023. In total, 69% of the cases were women and the age range was 1–96 years, with a median age of 68 years and an interquartile range (IQR) of 25–76 years. There was information on hospitalisation for 17 cases. Three cases (18%) were hospitalised due to the salmonellosis and seven (41%) for other reasons. Among 16 cases with information on the type of sample analysed, six (38%) had *Salmonella* isolated from urine. Predicted antimicrobial resistance determinants (*qnr*B19) and phenotypic resistance (MIC 0.25 µg/ml) to ciprofloxacin was identified.

Ireland reported **one** confirmed case with 0 AD from the German reference strain and with *qnr*B19 detected. The case was an immunocompromised adult male (45–64 years), who was hospitalised. The case had a primary sampling date in November 2022. The case had no recent international travel history and was not aware of receiving any food items from abroad.

The Netherlands reported **five** cases (three females and two males) with isolates closely related (0–1 AD) to the German reference strain. Two cases were from December 2022, two from January, and one from March 2023. One case was 20–30 years old, one 50–60 years and three were 70+ years old. Cases were geographically spread throughout the country. Information on food exposure was not available.

Norway reported **one** case of *S.* Senftenberg with domestically acquired infection in a female aged 50–60 years, with sampling date 17 February 2023. The bacterium was isolated from urine. The isolate had 0 AD from the representative German isolate and carried the *qnr*B19 gene. No additional epidemiological information was available.

Sweden reported **11** cases (seven females, four males) from nine different regions with isolates closely related (0–5 SNPs) to the German reference strain. The disease onsets or sampling dates were between 18 November 2022 and 24 June 2023. Some, but not all of the more recently reported cases were probably longer-term carriers, with symptom onsets early in 2023. Cases had an age range between 20 and 91 years, with a median age of 73 years. All cases were reported as having domestically acquired infections. In addition, all 11 isolates carried the gene *qnr*B19, predicting resistance against ciprofloxacin.

The UK reported **four** cases of *S.* Senftenberg in England matching the representative German outbreak strain (5-SNP designation according to the UKHSA pipeline 1.1.4.204.227.230.%). There were no reported cases in Scotland, Wales or Northern Ireland. Case sample dates ranged from 2 September 2022 to 29 January 2023. Two cases were female (aged 83 and 84 years) and two were male (aged 2 and 9 years). The cases were resident in three different regions of England. One case, interviewed by the local health protection team, an 83-year-old female, was hospitalised for three nights due to her symptoms, did not report travel within or outside the UK, did not report eating outside of the home, and did not report contact with animals. The case was not asked about specific food item exposure so there was no further information available.

The US reported **two** cases with 0–1 AD to the German reference strain. The first case was an adult female (47 years) reported in October 2022. The isolate was obtained from abdominal fluid. The second case was an immunocompromised male (42 years) with disease onset on 10 April 2023. The case received a liver transplant in 2022.

Information from patient interviews

An overview of reported food consumption data is presented in Table 2. The first preliminary interviews from Germany indicated consumption of fresh produce as a possible route of infection. Subsequent interviews regarding food consumption focused on specific fresh food items, with a couple of other common food items (cheese and eggs) reported as a reference category.

Table 2. Reported consumption of selected food items based on case interviews with available information from Austria, France, Germany, and Sweden, as of 12 July 2023

Country	Tomatoes*	Iceberg lettuce	Apples	Pears	Raspberries	Cheese	Eggs
Austria	5/5	4/5	3/5	2/5	1/5	4/5	5/5**
France	5/5	4/5	3/5	4/5	0/5	4/5	4/5**
Germany	6/6	3/6	4/6	2/6	3/6	3/6	5/6
Sweden	4/5	1/5	3/5	1/5	2/4	Nr***	Nr
Total	**20/21**	**12/21**	**13/21**	**9/21**	**6/20**	**11/16**	**14/16**

**Cases in Austria, France and Germany reported consumption of small (cherry) tomatoes. For Swedish cases, the types of tomatoes consumed were not specified.*

*** Cases in Austria reported consumption of eggs of various brands and from different laying hen houses. Cases in France report consumption of eggs in various forms, such as scrambled, fried, boiled or as an omelette.*

**** Nr = not reported.*

Cases in Austria purchased food at a local store near their home. Four of six German cases reported consumption of red cherry tomatoes packaged in a plastic bucket and two had consumed multi-coloured cherry tomatoes, but none reported consumption of ready-to-eat (RTE) salads. One Finnish case with a UTI reported having consumed cherry tomatoes of foreign origin before onset of symptoms. She also reported consuming RTE salads, possibly containing cherry tomatoes.

Microbiological and environmental investigations of food and control measures

This section summarises country-specific information on microbiological investigations, traceability analyses of products, and control measures implemented by the countries involved, as reported through the RASFF news **2023.2269** (27 EC validated follow ups (*fup*), as of 24 July 2023). A visual representation is provided in Figure 2.

France

On 28 April 2023, the food safety authority in France reported in RASFF (*fup2*) having detected the *S.* Senftenberg ST14 outbreak strain from a mixed salad dish produced on 17 August 2022 by the French Company A (*fup4*). The salad dish contained the following ingredients: fresh cherry tomatoes (yellow and red), green salad, lamb's lettuce, Frisée lettuce, red lettuce, chicory, fresh mozzarella, and canned black olives (*fup2*). The salad dish was accompanied by a dressing sauce provided separately (*fup8*). The salad dish was not served to the airline customers for which it was intended (*fup2*).

Based on the shared food exposure information, traceback investigations were performed on the cherry tomatoes contained in the salad dish. The French Company A sourced the cherry tomatoes of Batch A, Batch B, and Batch C from the Dutch Company B via the French Wholesaler A on 16–17 August 2022 (*fup4*).

The Netherlands

On 11 May 2023, the food safety authority in the Netherlands reported that the Dutch Company B had sourced the cherry tomatoes from three Dutch wholesalers, namely Company C (on 10 August 2022) (*fup5*), Company D (on 11 August 2022) (*fup5*), and Company E (tomatoes produced on 1 August 2022 with cultivation from May 2022 to April 2023) (*fup13*).

The Dutch Company C wholesaled the tomatoes from the Dutch Company P. The tomatoes were grown by the Dutch Grower E. In addition, the Dutch Company C received tomatoes grown by the Spanish Grower H, and by three Moroccan growers (Grower B, Grower C, Grower D) (*fup24*). The food safety authority reported that investigation of these connections is still ongoing.

The Dutch Company C is a common supplier among operators traced back in Austria (*fup17, fup18*) and those traced back in France (linked to the salad positive for the outbreak strain) (*fup2*, *fup5, fup10*) (Figure 2).

The Dutch Company D sourced tomatoes grown by the Dutch Grower F.

The Dutch Company E sourced tomatoes grown by the Dutch Grower G (Figure 2).

Salmonella testing information from the above-mentioned Dutch companies was not available from RASFF.

Further investigation was performed by the food safety authority on the type of water used and the microbiological testing performed by the growers.

The Dutch Grower E used basin water (rainwater) and source water (*fup10, fup24*) (pumped up from an underground source and not in contact with the products). The food safety authority reported that it had requested information on the type of treatment of the basin water used. The water and the products were not tested for *Salmonella*. The harvest period is end of July–August.

The Dutch Grower F used tap water (*fup9, fup24*) and tested the products for *Enterobacteriaceae* (negative results on 19 September 2022). The harvest period is April–August.

The Dutch Grower G used basin water (UV treated and stored in covered silos). The water and the products were not tested for *Salmonella*. The harvest period is May–April.

Austria

During the investigation into the possible cause of the outbreak infections in Austria, the authority tasked for this investigation (Institute for Infectious Disease Epidemiology and Surveillance) identified tomatoes and cherry tomatoes from the Austrian Company G as suspected vehicles. The suspicion of tomatoes and cherry tomatoes as the vehicle of infection was based on food exposure information (food frequency questionnaires and a second round of interviews with each outbreak case) and was not based on any microbiological evidence available from RASFF (*fup3*).

The suspected tomatoes originated from the Italian Consortium A (*fup6*) and had been delivered to five supermarkets in Austria (Groceries A-E of the same chain visited by five cases (*fup17,* and *fup18*) (Figure 2).

The supermarket chain was identified based on purchase information provided by the cases. Following the food exposure pointing to small tomatoes ('small tomatoes with vine'), the supermarket chain provided information on the small tomatoes delivered (two weeks prior the disease onset) to its supermarkets (where each case had purchased food).

On 26 June 2023, the food safety authority reported in RASFF on the outcome of further national investigations (*fup12, fup17,* and *fup18*) as a follow-up to the investigation previously (*fup5*) shared in RASFF by France and the Netherlands.

Between October 2022 and January 2023, the Austrian Company G had delivered tomatoes and cherry tomatoes to the five supermarkets (Groceries A–E) visited by five cases (*fup12, fup17,* and *fup18*) and was supplied with tomatoes by the German Company F and the Italian Consortium A (Figure 2), and by three Austrian suppliers (who had not imported their tomatoes from the Netherlands). Tracing investigations focused initially on the Italian Consortium A as the common supplier of the five supermarkets (Groceries A–E) visited by the cases.

Germany

Between October 2022 and January 2023, the German Company F was supplied with tomatoes and cherry tomatoes (sorted and packed at the company's packing station in the Netherlands, *fup25, fup26*) by nine wholesalers, as indicated (*fup14*) by the food safety authority in Germany. These were seven Dutch wholesalers (the Dutch Company C, the Dutch Company H, the Dutch Company I, Dutch Company J, the Dutch Company K, the Dutch Company L, and the Dutch Company M) and two Spanish wholesalers (Spanish Company N and Company O) (*fup14*, *fup17,* and *fup18*) (Figure 2).

The Dutch Company L and the Dutch Company M were identified as suppliers of the German Company F but excluded from the food investigation because of their delivery dates to Austria (late January 2023, when cases were no longer reported in Austria).

The Dutch Company C sourced tomatoes from growers located in Spain (Grower H) and Morocco (Growers B, C, and D) (*fup24*).

The Dutch Company H, the Dutch Company I, and the Dutch Company J sourced tomatoes from growers located in the Netherlands (food business operators not available in RASFF).

The Dutch Company K, the Dutch Company L, the Spanish Company N, and the Spanish Company O sourced tomatoes from growers located in Spain (food business operators not available in RASFF).

The Dutch Company M sourced tomatoes from growers located in Italy (food business operators not available in RASFF).

No microbiological information from the above-mentioned food business operators is available from RASFF (*fup12, fup14, fup17,* and *fup18*).

Spain

On 12 July and 24 July 2023, the food safety authority reported in RASFF that an investigation was ongoing in Spain in relation to the Spanish companies (Company N and Company O), traced back by the food safety authority in Germany (*fup23* and *fup27*).

Italy

On 12 May 2023, the food safety authority reported (*fup6*) on the traceback of the tomatoes originating from Italian Consortium A. The tomatoes, suspected to be the vehicle of the infections in Austria, were produced by the Italian Grower A and distributed to the Austrian Company G (*fup6*) (Figure 2).

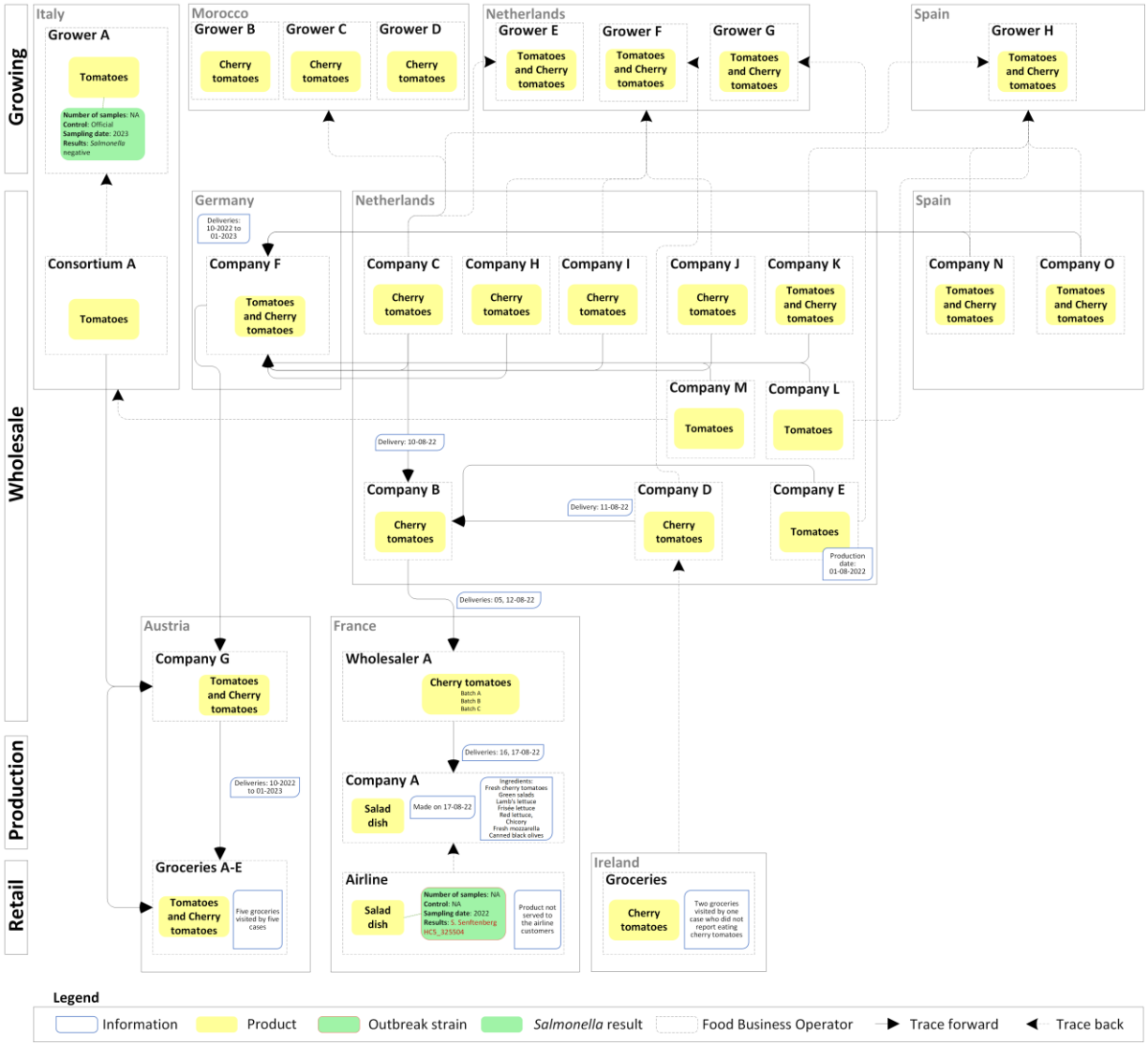
On 15 May and on 29 June 2023, the food safety authority performed official controls (*fup22*) at the Italian Grower A, which produces tomatoes (i.e. grape, cocktail, and cherry tomatoes) using a hydroponic cultivation system. At the Italian Grower A, rainwater from collection basins and treated surface water was used for irrigation. Potable and treated surface water was used for phytosanitary treatments. The tomatoes were packaged at the company's warehouse under controlled temperature conditions ('first-range' vegetables that are not yet ready for consumption). Microbiological sampling of the water (potable water, rainwater, and surface water after treatment) was carried out annually, although there was no sampling plan for tomatoes. On 29 June 2023, samples of tomato and irrigation water were collected and analysed for *Salmonella, Listeria,* and *E. coli*. Tomatoes tested negative for the three pathogens, and results for the irrigation water samples were not yet available from RASFF (*fup22*). The food safety authority reported that work was ongoing at the company to implement a sampling plan for tomatoes and water, and to improve the labelling of the final products.

Ireland

On 18 April 2023, the food safety authority reported on the food investigation carried out with the shopping information available from the two groceries visited by the Irish case. The Irish case (from November 2022) did not report eating cherry tomatoes (*fup1, fup20*).

On 27 June 2023, the food safety authority reported (*fup 20*) on the outcome of further investigations related to the two groceries (food business operators not available in RASFF) visited by the Irish case and identified a common supplier of cherry tomatoes: the Dutch Company D (Figure 2). The Dutch Company D was traced back and identified as one of the suppliers of Dutch Company B which was linked to the salad dish testing positive for the outbreak strain in France.

Figure 2. Graphical representation of traceability, based on testing information for the contaminated food and food exposure information, as reported by the countries involved under RASFF notification 2023.2269 (*fup*27 as of 24 July 2023)



European whole genome sequencing analysis of human and non-human isolates

The WGS data for 19 representative isolates from humans were collected in Austria (n=5), Germany (n=1), Norway (n=1), Sweden (n=7), the UK (n=4), and the US (n=1) and submitted to ECDC. The isolates' sequences were collected from cases reported between September 2022 and April 2023. Human isolates were analysed by ECDC using BioNumerics version 7.6.3 (Applied-Maths, Sint-Martens-Latem, Belgium), which included raw sequence trimming using the default settings; de novo assembly including mismatch correction using SPAdes v.3.7.1. Allele calling was performed on assemblies using the EnteroBase core genome scheme and isolates were excluded from further analysis if less than 2 702 (90%) of the 3 002 core loci were detected.

For cross-sectoral analysis, the cgMLST analysis was performed by both ECDC and EFSA, as previously described [4]. Briefly, genome profiles were calculated from assembled genomes using chewBBACA version 2.8.5 (https://hub.docker.com/layers/ummidock/chewbbaca/tags; https://github.com/B-UMMI/chewBBACA), according to the schema described by Rossi et al. 2018 [5] for *Salmonella* enterica, made available by the Chewie Nomenclature Server (ChewieNS)[1] [6]. Isolates with more than 10% of missing loci (325 out of a total of 3 255 loci) were excluded from the analysis.

EFSA launched calls for data, inviting all EU/EEA Member States to submit genomic information to the EFSA One Health WGS System regarding *S.* Senftenberg food isolates collected between 2021 and 2023, focusing on isolates collected from fruit and vegetables, including tomatoes and cherry tomatoes.

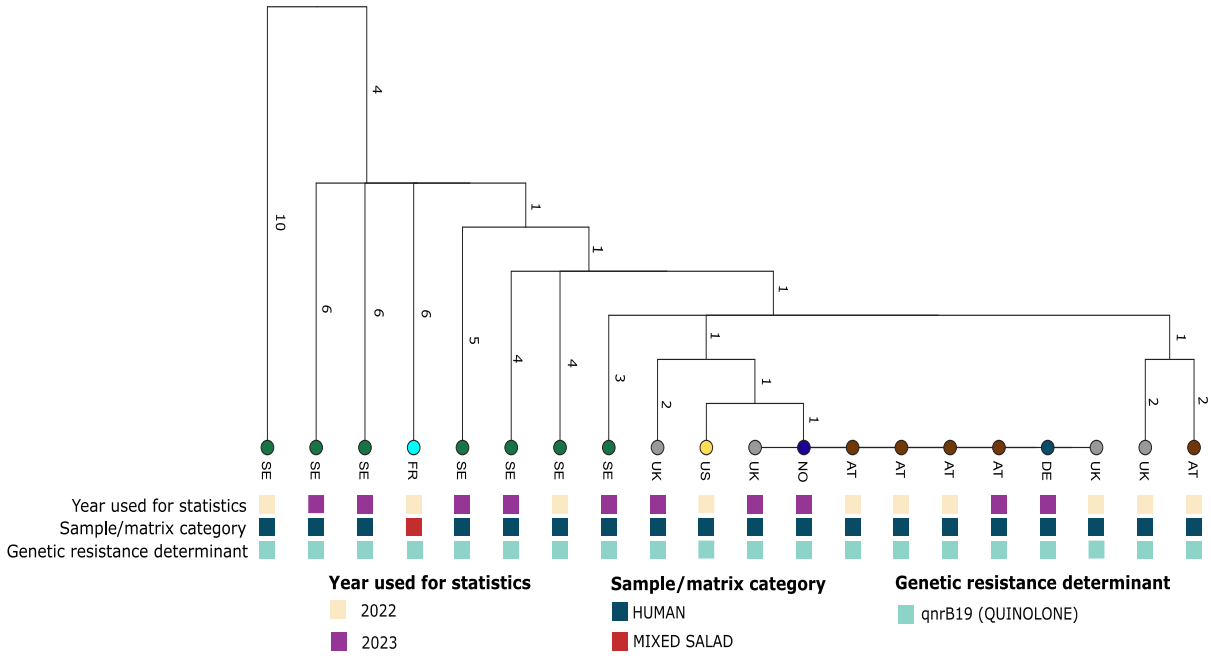
By 3 July 2023, a total of 33 profiles of non-human isolates had been shared in the EFSA One Health WGS system by six countries: Denmark, France, Germany, the Netherlands, Poland, and Spain. There were 13 profiles relating to meat, soy sauce, and unknown matrices from Denmark; one profile relating to a mixed salad from France; two profiles relating to dried herbs and spices from Germany; one profile relating to dried herbs and spices from the Netherlands; two non-food matrices and one unknown matrix from Poland; and 13 profiles relating to an unknown matrix from Spain. The total number of profiles of *S.* Senftenberg ST14 available in the EFSA One Health WGS system database at the time of analysis (including those generated from data retrieved from a public repository) was 110.

ECDC sent a batch of WGS data to query in the EFSA One Health WGS System on 13 July 2023, using the cluster of 19 human *S.* Senftenberg isolates as reference genomes. This comparison revealed one allelic profile of *S.* Senftenberg ST14 non-human isolate with 6 AD from the cluster. This isolate originated from the mixed salad sampled in France (RASFF 2023.2269, *fup2*) and was shown to carry the *qnr*B19 gene.

In total, 20 *S.* Senftenberg sequences from human (n=19) and non-human isolates (n=1) were included in the single linkage cluster (Figure 3). A single linkage dendrogram was generated using the allelic distance with the Enterobase scheme for the human isolates and the ChewieNS scheme for the non-human isolates. The tree was generated using the MicroReact tool. The single linkage tree visualises the distribution of reporting countries, origins of the isolates and relevant resistance determinant respectively (Figure 3). All isolates are within 10 AD in a single linkage clustering and carry the *qnr*B19 gene encoding resistance to quinolones. Specifically, for sequences generated using the IonTorrent platform, larger allelic distances were seen due to artefacts from the assembly pipeline, as evidenced for the Swedish data with up to 10 ADs. However, the national clustering pipeline corroborates the fact that these sequences meet the case definition for a confirmed outbreak case.

[1] Chewie Nomenclature Server available at: https://chewbbaca.online/species

Figure 3. Single linkage tree (EnteroBase and ChewieNS core genome MLST schemes) of 20 representative *S.* Senftenberg sequences, including 19 human isolates* and one non-human isolate, as of 13 July 2023



**The larger allelic distance of 10 AD for the Swedish case is due to artefacts from the assembly pipeline. However, the national clustering pipeline corroborates the fact that these sequences meet the case definition for a confirmed outbreak case.*

ECDC and EFSA risk assessment for the EU/EEA

A cross-border outbreak of *S.* Senftenberg has evolved in 11 EU/EEA countries, the UK, and the US since August 2022. As of 12 July 2023, a total of 92 cases (81 confirmed and 11 possible) have been identified. The first date of isolation was on 18 August 2022 in France, and the most recent case was reported on 24 June 2023 in Sweden. Infections have occurred across all age groups and female cases predominate with female-to-male ratio of 2.3:1. Several cases are reported to have been hospitalised, as well as one death, highlighting the severity of illness among infected patients. Indeed, one third of patients with information available regarding the type of sample (15 of 44; 34.1%) were reported to have had *Salmonella* isolated from urine samples, indicating the possibility of extraintestinal infection and for one patient, the isolation came from abdominal fluid. This may be related to predisposing risk factors among patients, such as underlying health conditions.

Among 21 cases interviewed in Austria (5), France (5), Germany (6), and Sweden (5), 20 (95.2%) reported consumption of tomatoes (small tomatoes, cherry tomatoes, grape tomatoes, Roma tomatoes or unspecified tomatoes) and 12 (57.1%) reported consumption of iceberg lettuce. Of 16 cases, 14 (87.5%) reported consumption of eggs. However, although all five cases in Austria reported consuming eggs, they were of different brands, from a variety of laying hen farms with no common link. On the other hand, all five cases reported consumption of small red tomatoes from a local store near their home (same supermarket chain), thus sharing a common type of exposure and an epidemiological link.

Following the detection of the outbreak strain from a mixed salad dish (not served), the food safety authority in France focused traceback investigations on the red and yellow cherry tomatoes contained in the salad among the other ingredients (not including eggs). The food safety authority in Austria traced back the cherry tomatoes, as the suspected vehicle of infections, available at the groceries visited by the Austrian cases. The tomatoes in France and in Austria were traced back to wholesalers in Germany, the Netherlands, and Spain, and to growers in the Netherlands, Spain, and Morocco. The Dutch Company C is a common trading link between France and Austria.

In the absence of microbiological evidence from tomatoes, the source(s) of the infection has not been established. Investigations are ongoing.

The comparison of the representative outbreak strains with the available genome profiles of *S.* Senftenberg from human and non-human isolates revealed that the food isolate from a mixed salad was genetically close (≤ 6 AD) to the human isolates. The mixed salad was prepared in France on 17 August 2022, which is very close to the time of detection of the first human case in France, with isolation date 22 August 2022, suggesting that the suspected contaminated food vehicles entered the French market around mid-August 2022 and other EU/EEA countries later.

All human and food isolates in the centralised single linkage clustering analysis possessed the *qnr*B19 gene encoding resistance to quinolones, thus suggesting a shared pressure to develop quinolone resistance. Resistance of *Salmonella* strains from humans and animals to antibiotics is reported annually in the European Union summary report. In 2020, quinolone resistance was reported as high to very high among *Salmonella* isolates recovered from poultry and moderate in human cases from 2021 [7].

The intermittent reporting of cases between August 2022 and June 2023, and the genetic similarity of the outbreak strains indicates prolonged distribution of contaminated food from a common source(s) for about 10 months in the EU/EEA and the UK. The identification of microbiologically linked cases in the US suggests a possible common source of infection or travel linked to Europe.

Given all the information collected so far, *Salmonella*-contaminated cherry-like tomatoes are a possible vehicle of the human infections reported in this outbreak. The contamination may have occurred at pre-harvest during the growing of the tomatoes via different sources (e.g. using *Salmonella*-contaminated water, including re-used irrigation water). Available information has not revealed a common epidemiological (trade) link between the food business operators, the tomato growers, and the countries reporting cases.

With the exception of the most recent case reported by Sweden in late June 2023, new cases have not been reported in other countries since early May 2023, suggesting that a common source(s) of the suspected contaminated tomatoes is not active anymore. Consequently, the risk of new infections has decreased to a low level in the EU/EEA.

Identifying the nature and source (root cause) of microbial contamination of vegetables in the food chain remains crucial to ensure appropriate handling and activities by growers, producers, wholesalers, retailers, and consumers and to prevent the risk of food-borne human illness deriving from exposure to *Salmonella*-contaminated vegetables.

Recommendations and options for response

ECDC encourages public health authorities to continue collaborating with the food safety authorities and to consider using and sharing photographs of potential food vehicles (including suspected tomatoes and their packaging) based on case interviews to facilitate the food investigations, particularly in countries where cases have been notified. Should new information become available, please update your country's public health data in EpiPulse 2023-FWD-0009. ECDC can also offer sequencing support.

EFSA encourages Member States to perform sequencing of *S.* Senftenberg food isolates related to the RASFF notification 2023.2269 and/or linked to the present cluster, either microbiologically (serogroup or ST) or epidemiologically (e.g. consumption of vegetables including tomatoes by human cases or isolates linked to the companies involved as in RASFF 2023.2269). EFSA also recommends the submission of genomic data for *S.* Senftenberg isolates from any kind of food, feed, animals, and related environment to the EFSA One Health WGS System. Further food investigation into the possible cause of human infections, including the identification of the source of infections (root cause analysis) is recommended. This will allow appropriate control measures to be implemented.

Among the food/pathogen combinations affecting food of non-animal origin, *Salmonella* spp. and tomatoes ranked as the second most common combination [8]. To reduce the public health risk derived from microbiological contamination of vegetables, adherence to appropriate agricultural and hygiene practices is of the utmost importance during the growing and harvesting, post-harvest sorting, processing, and shipping, including regular *Salmonella* testing of irrigation water and products.

Source and date of request

ECDC sent a request to EFSA on 22 June 2023 to produce a Joint Rapid Outbreak Assessment (ROA). EFSA accepted the request on 22 June 2023.

Consulted experts and national contact points

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Estonia: Jevgenia Epstein (Health Board).
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RASFF contact points: Austria, France, Germany, Ireland, Italy, the Netherlands, Spain.
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Italy: Loredana Iuliano (Ministry of Health).
Netherlands: Coen van der Weijden, Ad van Sambeek, Thom Roethof (Netherlands Food and Consumer Product Safety Authority (NVWA)

National experts consulted by the Country Officer of the EFSA One Health WGS system:
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Disclaimer

This rapid outbreak assessment was written jointly by the European Centre for Disease Prevention and Control (ECDC) and the European Food Safety Authority (EFSA).

ECDC issued this outbreak assessment document in accordance with Article 20 of Regulation (EU) 2022/2371 on serious cross-border threats to health, Articles 7(1) and 8a of Regulation (EC) No 851/2004 establishing a European Centre for Disease Prevention and Control. EFSA's contribution is based on a mandate from the European Commission requesting EFSA to provide scientific assistance from EFSA in the investigation of multinational food-borne outbreaks (Ares (2013) 2576387, Mandate M-2013-0119, 4 July 2013) in accordance with Article 31 of Regulation (EC) No 178/2002 of the European Parliament and of the Council of 28 January 2002, laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety.

The specific purpose of an ECDC-EFSA rapid outbreak assessment is to present an analysis of a cross-border food-borne threat to health and to provide science-based recommendations and options for response. The responsibility for the choice of which options to pursue and which actions to take at national level, following ECDC and EFSA's recommendations, lies with EU Member States and European Economic Area (EEA) countries.

All data published in this rapid outbreak assessment are data collected from EU and/or EEA countries concerned by the outbreak until the date this assessment was produced. Maps and figures published do not represent statements from ECDC or EFSA on the legal or border status of the countries and territories shown but constitute the information on which this rapid outbreak assessment is based.

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Annex - Disease background

Disease characteristics

Background information about salmonellosis can be found on the websites of ECDC, US CDC, and WHO [9-11].

Surveillance of *Salmonella* Senftenberg infections in the EU/EEA and the United Kingdom

This section summarises country-specific data on human *S.* Senftenberg cases as reported to The European Surveillance System (TESSy) by EU Member States in accordance with ECDC's founding regulation (Regulation (EC) 851/2004) and Decision No 1082/2013/EU on serious cross-border threats to health.

Salmonella Senftenberg is reported as part of salmonellosis surveillance in the EU/EEA. Notification of non-typhoidal salmonellosis is mandatory in most of the EU Member States, as well as in Iceland and Norway. In four Member States, reporting is voluntary (Belgium, France, Luxembourg, and the Netherlands). Food poisoning is a notifiable disease under national legislation in all the countries of the UK, except for Scotland. Under this legislation, reporting of *Salmonella* spp. isolated from human samples in public health laboratories is also mandatory throughout the UK. The surveillance systems for salmonellosis have national coverage in all Member States except three (Belgium, the Netherlands and Spain). The population coverage in 2021 was estimated to be 85% in Belgium and 64% in the Netherlands. For Spain, the population coverage was not reported for 2021.

Between 2007 and 2021, 2 174 cases of *S.* Senftenberg were reported to the European Surveillance System (TESSy) by 26 EU/EEA countries and the UK (data as of 22 March 2023). The average number of cases per year was 145, ranging from 36 cases in 2020 to 260 cases in 2007 (Figure A1). The UK accounted for 30% (n=651) of all cases, followed by Germany with 20% (n=427) and France with 9% (n=201). Among cases with known importation status (n=1 437), 62% (n=896) were reported as domestically acquired infections. Among imported cases with known probable country of infection (n=449), 18% (n=83), 12% (n=52) and 11% (n=49) reported travel to Egypt, Thailand and India, respectively.

In 2020 and 2021, 36 and 75 cases respectively, were reported to TESSy; it is possible that the cases in 2020 and 2021 are underreported compared to previous years due to the COVID-19 pandemic. Furthermore, for the period 2020−2021, no data were reported by the UK due to its withdrawal from the EU on 31 January 2020. During all years of surveillance, *S.* Senftenberg ranked 48th out of 1 210 reported serotypes.

Among cases with known gender (n=2 125), 55% (n=1 176) were female, which is slightly higher than the proportion of female cases (49.9%) among all salmonellosis cases reported to TESSy between 2007 and 2021. With the exception of 2014, where an equal number of male and female *S.* Senftenberg cases were reported, for all other years, more female cases were reported than males (Figure A2). Among domestically acquired infections, a similar gender distribution was observed (Figure A3). When stratified by age group, there is some evidence of a difference in the number of male to female cases in the 15−24 years, and 65+ years age groups (Figure A4). In the period between 2007 and 2021, a slight peak in cases was observed in August and September, accounting for 22% (n=489) of all reported cases (Figure A5). This is consistent with data for all salmonellosis cases reported to TESSy between 2007 and 2021, with 26% of all cases being reported in the months of August and September.

Data on antimicrobial susceptibility was available for 258 cases of *S.* Senftenberg reported by 18 EU/EEA countries (including the UK up until 2019) between 2017 and 2022. Resistance to most antimicrobials was uncommon but highest to ciprofloxacin, sulfamethoxazole, and chloramphenicol (resistance observed in 8.5%, 6.9% and 6.8% of isolates, respectively). No isolates were resistant to both of the first line antimicrobial classes (fluoroquinolones and third- and fourth-generation cephalosporins) used to treat severe *Salmonella* infections. Resistance to ciprofloxacin was higher in 2022 (33.3%) than in previous years, but this could be due to incomplete data as the 2022 data collection was still ongoing at the time of analysis.

Further information can be found in ECDC's annual epidemiological report of salmonellosis for 2021 [12] and the online 'Surveillance Atlas of Infectious Diseases' [13].

Figure A1. Distribution of *S.* Senftenberg cases by year, EU/EEA and the UK (up to and including 2019), 2007–2021, (n=2 174)

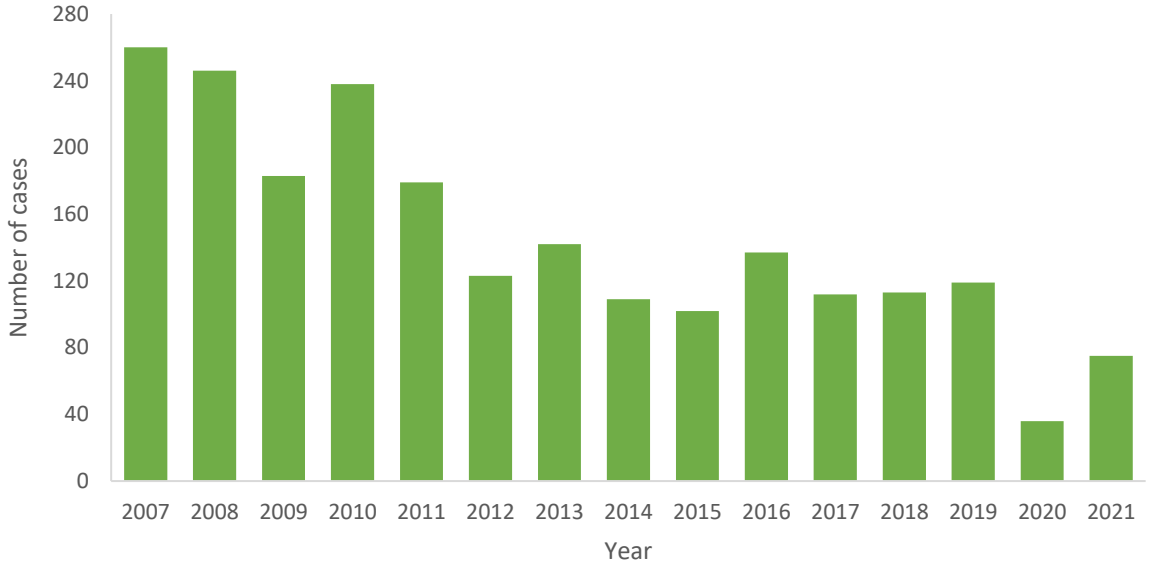


Figure A2. Distribution of *S.* Senftenberg cases by gender and year in the EU/EEA countries and the UK (up to 2019), 2007–2021 (n=2 125)

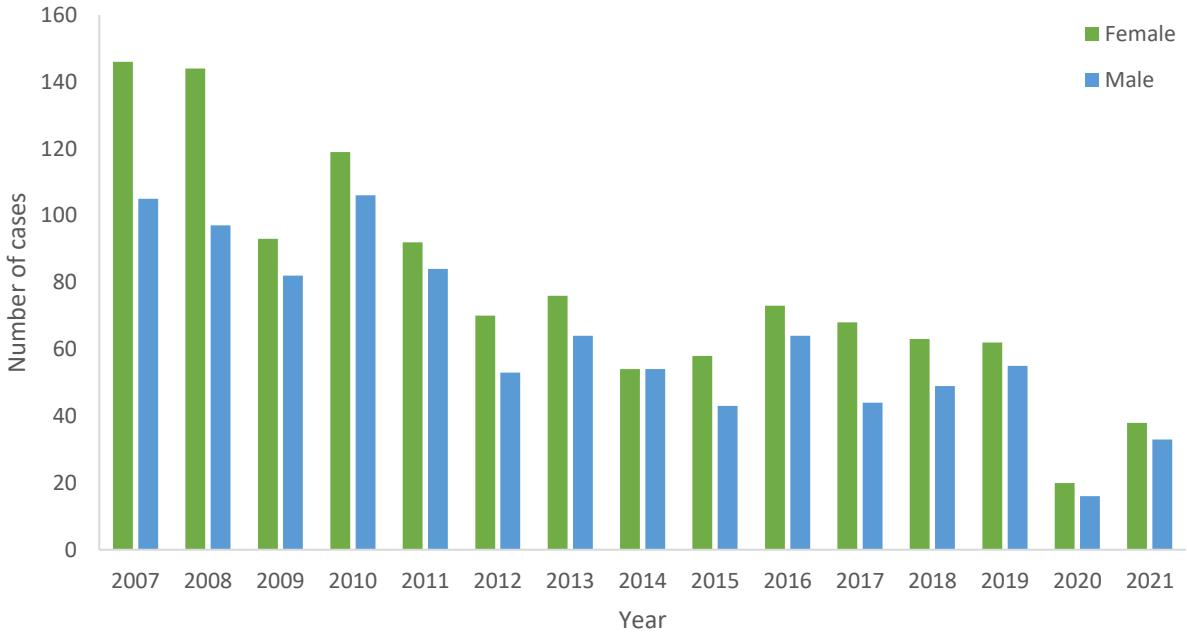


Figure A3. Distribution of domestically acquired *S.* Senftenberg infections by gender and year in the EU/EEA and the UK (up to 2019), 2007–2021 (n=1 588)

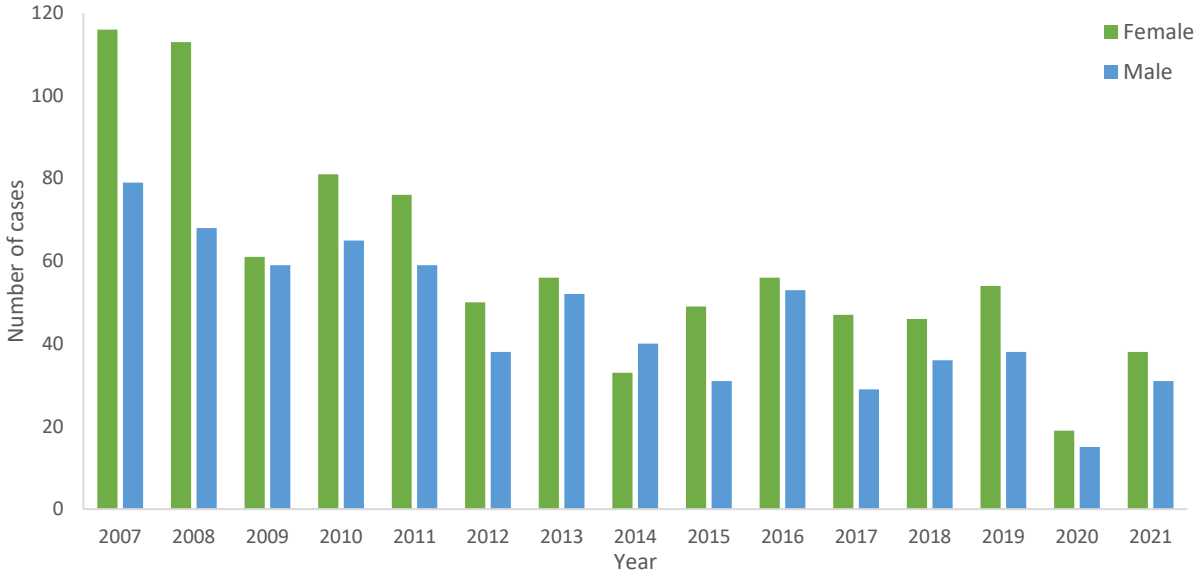


Figure A4. Distribution of *S.* Senftenberg cases by age group and gender in the EU/EEA and the UK (up to 2019), 2007–2021 (n=2 068)

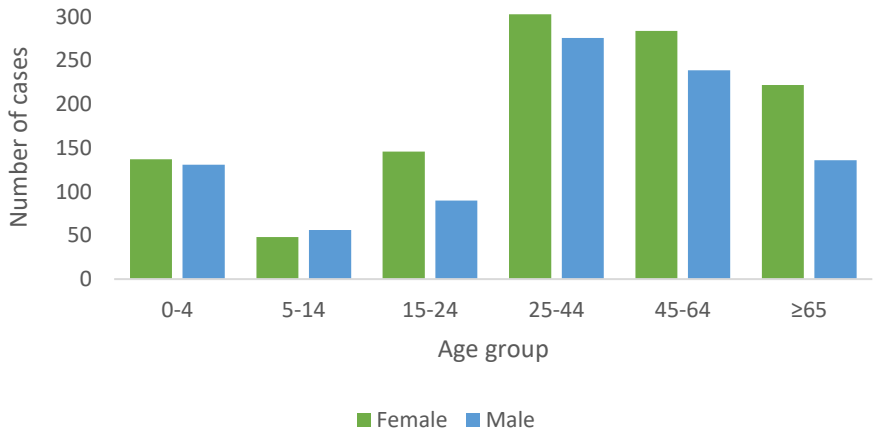
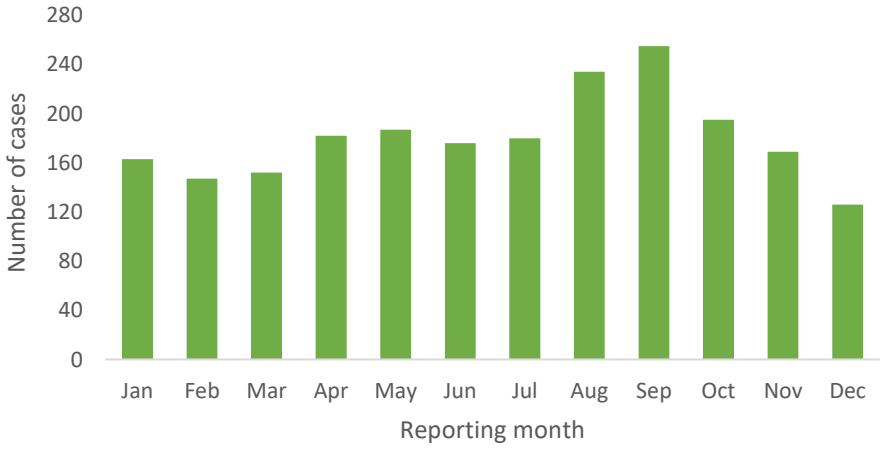


Figure A5. Distribution of *S.* Senftenberg cases by month in the EU/EEA and the UK (up to 2019), 2007–2021 (n=2 174)



Food-borne outbreaks caused by *S.* Senftenberg

This section summarises country-specific data on food-borne outbreaks associated with *S.* Senftenberg, as reported to EFSA by the Member States between 2017 and 2021 in accordance with the Zoonoses Directive 2003/99/EC.

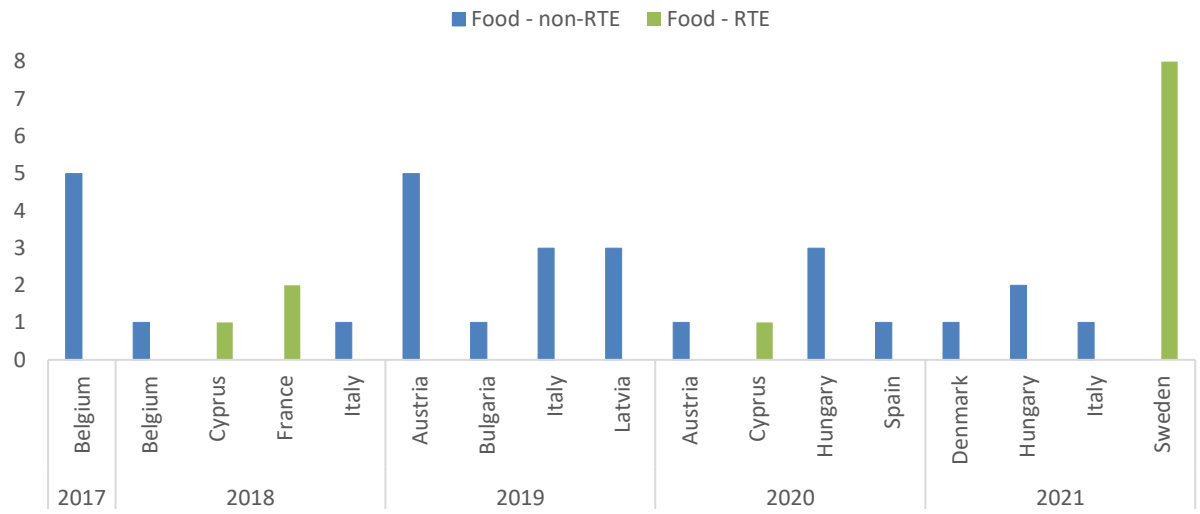
During these five years, one strong-evidence food-borne outbreak caused by *S.* Senftenberg was reported by Croatia in 2017. The reported food vehicle was 'Meat and meat products'. In total, 57 human cases were reported, with four hospitalised patients and no deaths.

Occurrence of *S.* Senftenberg in ready-to-eat (RTE) and not-RTE food

This section summarises country-specific data on the occurrence of *S.* Senftenberg for the matrices 'Food – RTE' and 'Food non-RTE' from 2017 to 2021, as reported to EFSA by the EU Member States in accordance with the Zoonoses Directive 2003/99/EC.

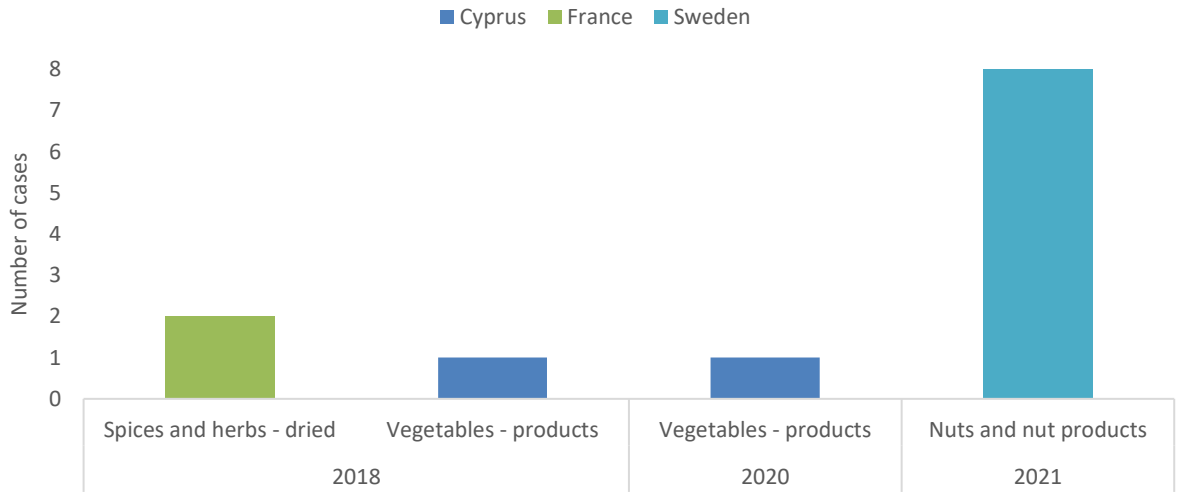
During these five years, 40 units positive for *S.* Senftenberg from a total of 3 576 073 units tested for *Salmonella enterica* (0.0011%) were reported to EFSA for the overall matrices 'Food RTE' and 'Food non-RTE' by 11 EU Member States (Austria, Belgium, Bulgaria, Cyprus, Denmark, France, Hungary, Italy, Latvia, Spain and Sweden).

Figure A6. Distribution of the 40 *S.* Senftenberg positive samples from the matrices 'Food RTE' and 'Food non-RTE' as reported by 11 EU Member States between 2017-2021



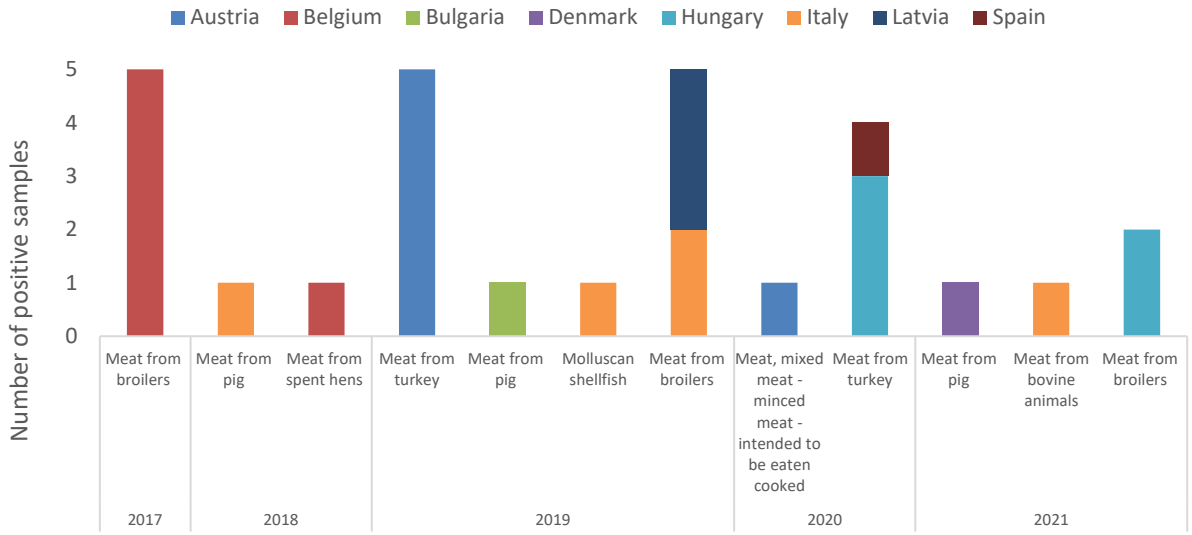
The 12 units positive for *S.* Senftenberg out of the 577 963 total units tested for *Salmonella enterica* (0.0020%) (EU/EFTA countries) for the matrix 'Food RTE' were reported by three EU Member States (two units positive from 'Spices and herbs - dried' reported by France in 2018, two units positive from 'Vegetables - products' reported by Cyprus in 2018 and in 2020, and eight units positive from 'Nuts and nut products' reported by Sweden in 2021).

Figure A7. Distribution of the 12 *S.* Senftenberg positive samples from the matrix 'Food RTE', as reported by three EU Member States 2017–2021



Of the 3 086 837 total units tested for *Salmonella enterica* (0.0009%) (EU/EFTA countries) for the matrix 'Food non-RTE', the 28 units positive for *S.* Senftenberg belonged to the following matrices: 13 units positive as 'Meat from broilers' and 'Meat from spent hens (*Gallus gallus*)' (five units reported in 2017 and one in 2018 by Belgium, two units reported by Italy, and three units by Latvia both in 2019, two units reported by Hungary in 2021); nine units positive as 'Meat from turkey' (five units reported by Austria in 2019, three units from Hungary in 2020, and one unit from Spain in 2020); three units positive as 'Meat from pig' (one unit from Italy in 2018, one unit reported by Bulgaria in 2019, and one unit reported by Denmark in 2021); one unit positive as 'Meat from bovine animals - carcass' (reported by Italy in 2021), one unit positive as 'Meat, mixed meat - minced meat - intended to be eaten cooked' (reported by Austria in 2020), and one unit positive as 'Molluscan shellfish - raw' (reported by Italy in 2019).

Figure A8. Distribution of the 28 *S.* Senftenberg positive samples from for the matrix 'Food non-RTE' as reported by eight EU Member States, 2017–2021



During the same period, of 10 350 total units tested for *Salmonella enterica* there were no units positive for *S.* Senftenberg reported for the matrix 'Food RTE' by non-EU Member States. During the period 2017–2020, the United Kingdom was an EU Member State.

Two non-EU Member States (Albania and the UK) reported four units positive for *S.* Senftenberg out of 38 921 total units tested for *Salmonella enterica* (0.0102%) for the matrix 'Food non-RTE'.

These four units belonged to the following matrices: two units positive as 'Meat from broilers' and 'Meat from spent hens (*Gallus gallus*)' (one unit reported in 2017 and one in 2020 by the UK), one unit positive as 'Meat from pig' (reported in 2017 by the UK), and one unit as 'Meat, mixed meat - meat preparation - intended to be eaten cooked' (reported in 2021 by Albania).