
***Salmonella enterica* in the Estonian meat production chain 2016-2020**

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Salmonellosis

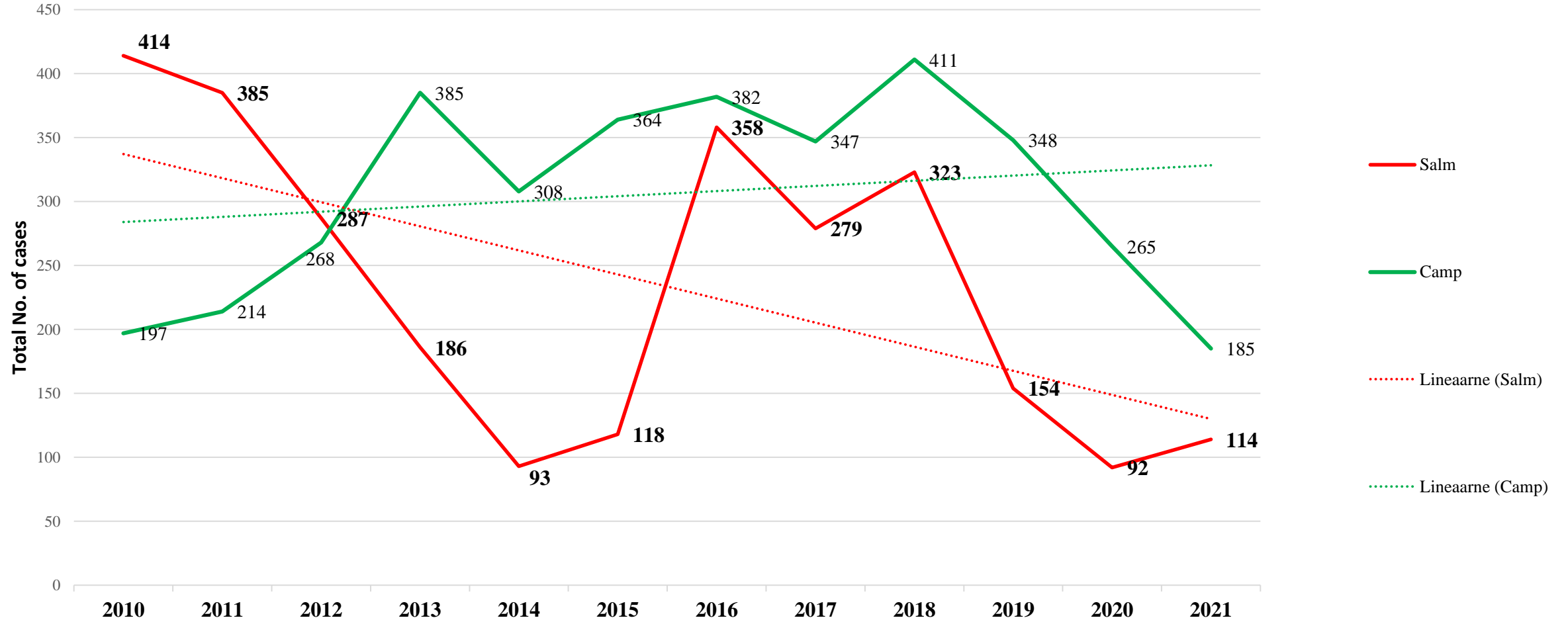
- **Salmonellosis** can be divided into **four disease patterns**:
 - gastroenteritis;
 - enteric fever;
 - bacteremia with or without extraintestinal infection;
 - the asymptomatic carrier state.
- *Salmonella* gastroenteritis usually follows the ingestion of contaminated food/water.
- Certain serotypes are associated with particular clinical syndromes e.g. *S. Typhimurium* and *S. Enteritidis* with gastroenteritis; *S. Typhi* and *S. Paratyphi* with typhoid or enteric fever.
- For general food safety applications, **all salmonellae should be considered potentially pathogenic.**

Five most common human zoonoses in EU, 2018-2020

Impact of the Covid-19 pandemic

		Disease cases		Decrease %
Zoonoses	2018	2019	2020	
Campylobacteriosis	246,572	220,682	120,946	45.2
Salmonellosis	91,857	87,923	52,702	40.1
Yersiniosis	6,699	6,961	5,668	18.6
STEC infections	8,161	7,775	4,446	42.8
Listeriosis	2,549	2,621	1,876	28.4
Total	355,838	325,962	185,638	43.0

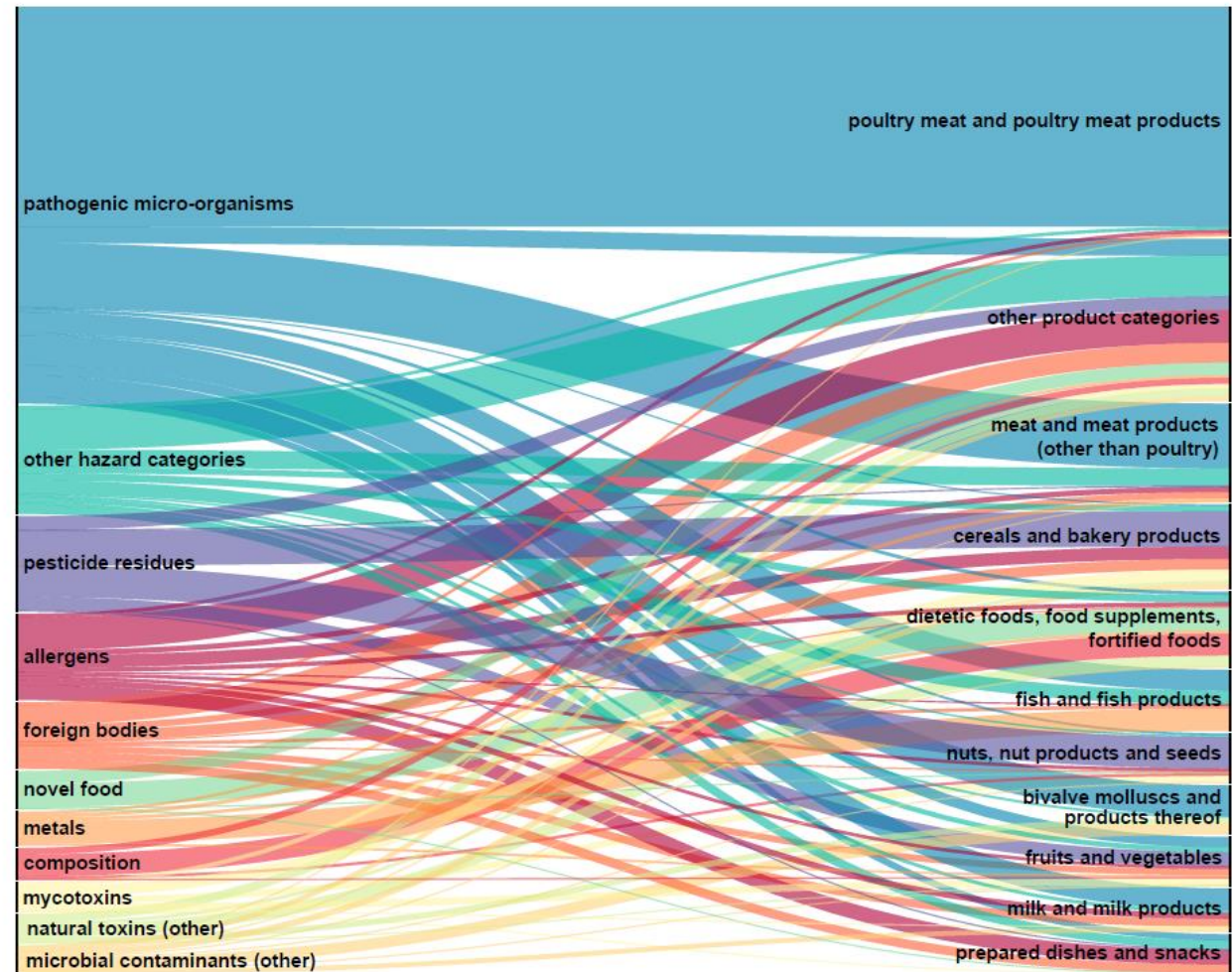
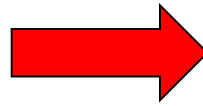
Salmonellosis and *Campylobacter* enteritis cases in Estonia in 2010-2021



Two big *Salmonella* foodborne outbreaks in 2016: one with 88 cases of *S. Infantis*, another with 70 cases of *S. Enteritidis*
In 2017, there was one outbreak with 17 cases (*S. Typhimurium*) and another with 12 cases (monophasic *S. Typhimurium*)
In 2018, there was one outbreak with 82 cases (*S. Enteritidis*) and another major outbreak with 23 cases (*S. Enteritidis*)

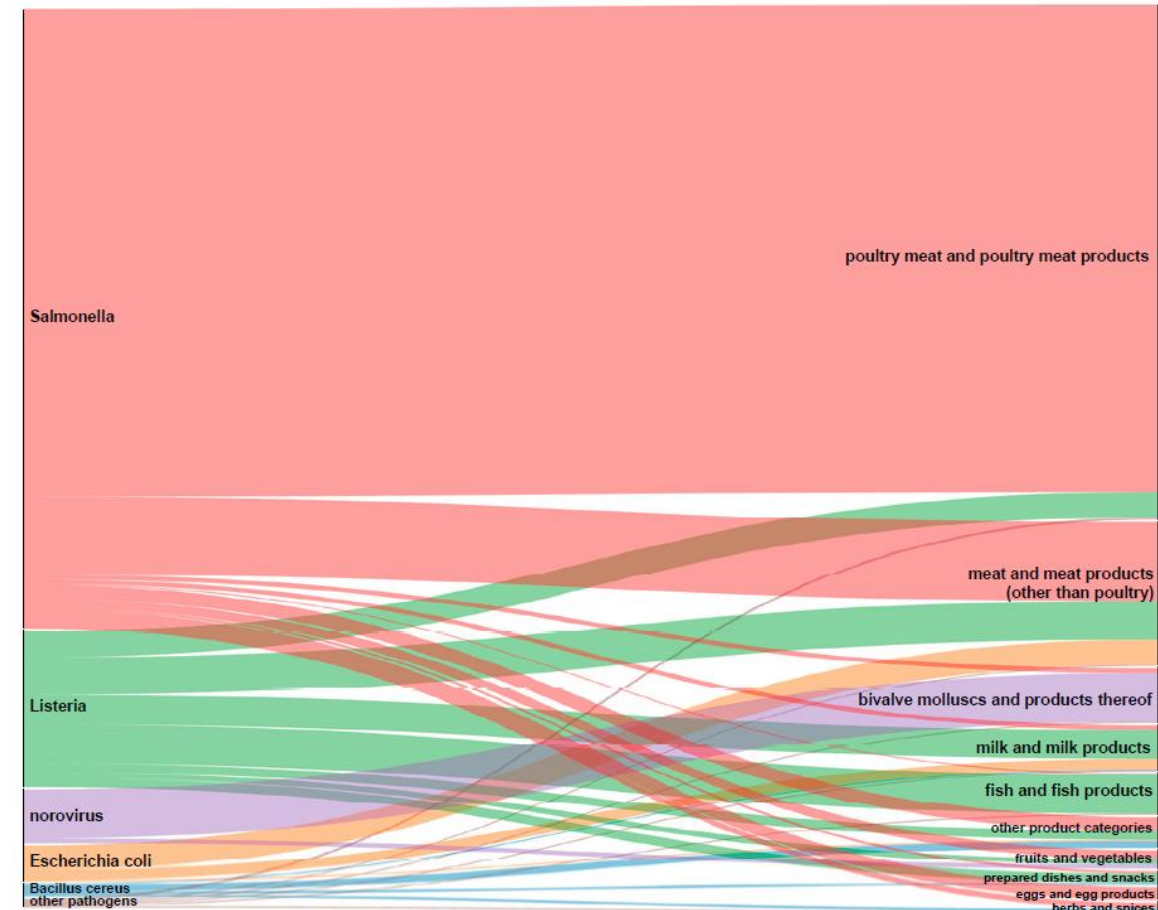
RASFF Annual Report 2020

Pathogenic microorganisms in food of animal origin are of significant part of the RASFF notifications

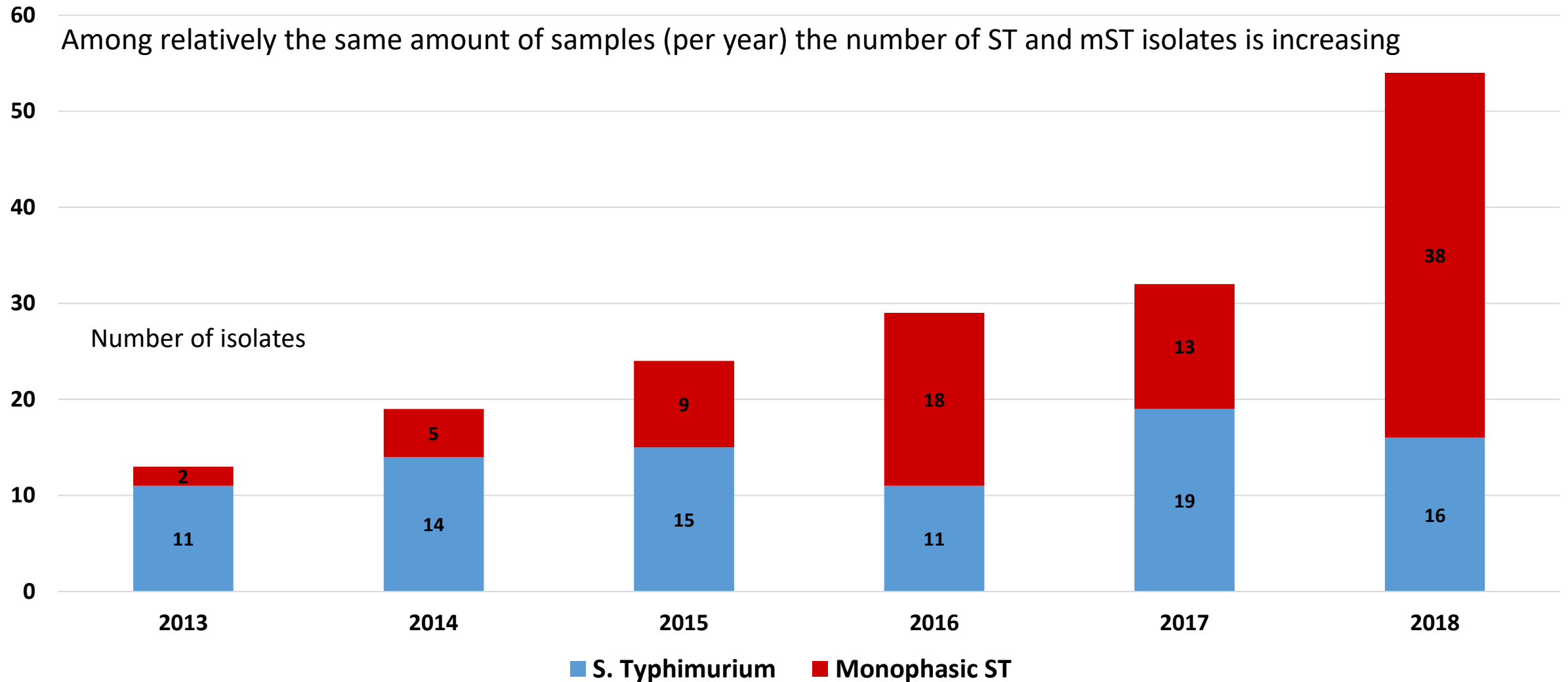


RASFF Annual Report 2020

- Pathogenic microorganisms: **788 notifications in year 2020**
 - **27.0% increase** compared to 2019 (n = 575 in 2019)
- *Salmonella* is more than ever the most frequently reported pathogen in food with **537 notifications**
 - **30.9% increase** compared to 2019 (n = 371 in 2019);
 - mostly poultry meat and poultry meat products and *S. Enteritidis* as the most prevalent serotype.

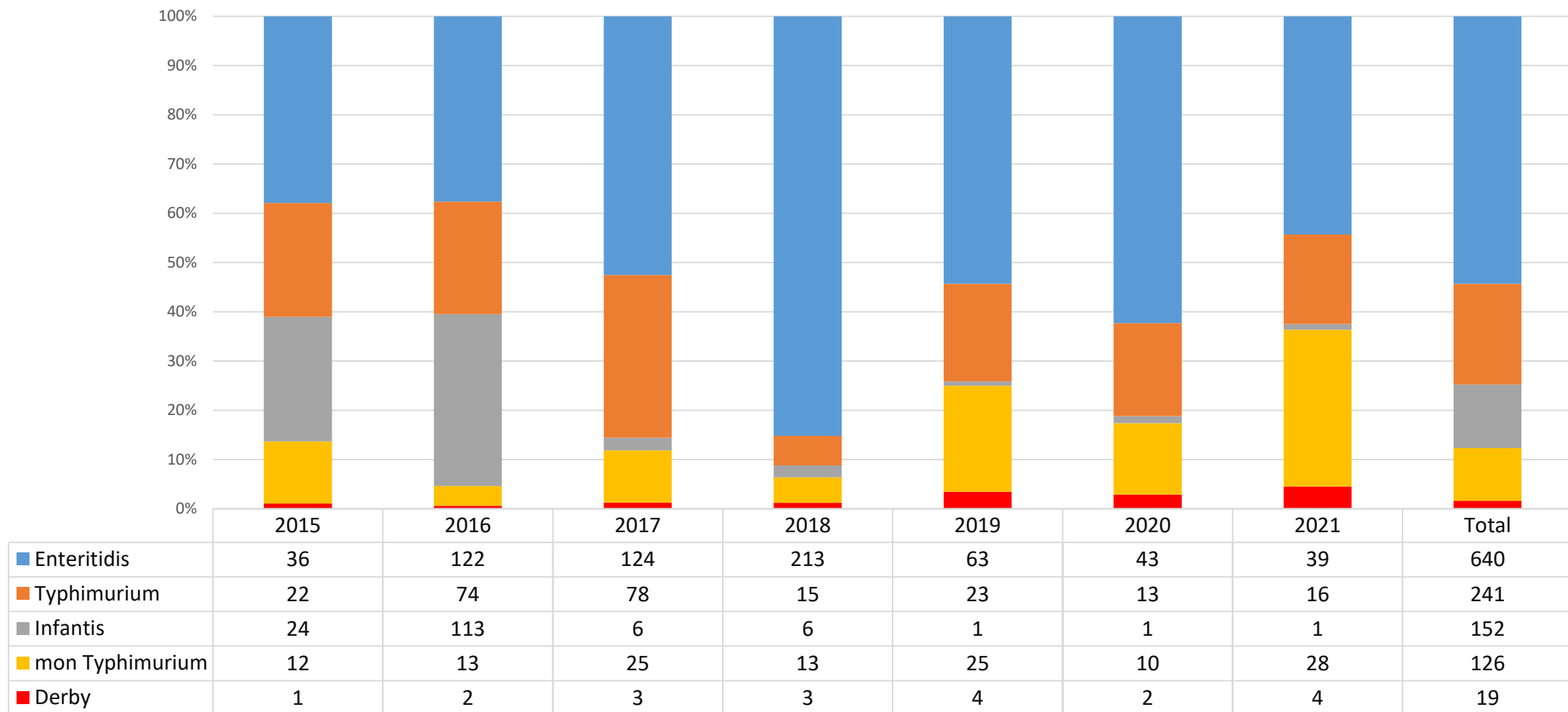


Salmonella Typhimurium and its monophasic variant in meat production chain, 2013 – 2018, Estonia



Top 5 *Salmonella* serotypes among of human infections

2015-2021, Estonian Health Board




The number of serotype related human salmonellosis cases


Salmonella serotypes isolated in Estonia in 2019

Human cases, Estonian Health Board

Serotüüp	S. Albany	S. Braenderup	S. Derby	S. Dublin	S. Enteritidis	S. Hvitittingfoss	S. Infantis	S. Javiana	S. Leeuwarden	S. Litchfield	S. Muenchen	S. Muenster	S. Napoli	S. Oranienburg	S. Stanleyville	S. Typhimurium	S. Typhimurium monofaasne	S. Virchow	S. S-grupp	S. spp	Kliin+epid	Kokku
Haigete arv	1	1	4	2	63	1	1	2	1	1	2	1	1	2	2	23	25	2	1	14	4	154
%	0,6	0,6	2,6	1,3	40,1	0,6	0,6	1,3	0,6	0,6	1,3	0,6	0,6	1,3	1,3	14,9	16,2	1,3	0,6	9,1	2,6	



40.1%



31.1%

Salmonella serotypes isolated in Estonia in 2020

Human cases, Estonian Health Board

Tabel 1. Isoleeritud salmonellade serotüübid, 2020. a

Piirkond	S. Bareilly	S. Bredeney	S. Derby	S. Enteritidis	S. Hadar	S. Infantis	S. Java	S. Muenchen	S. Newport	S. Senftenberg	S. Stachus	S. Thompson	S. Typhimurium	S. Typhimurium monofaasne	S. B- ja D-grupp	S. spp	Kokku
Kokku	1	1	2	43	1	1	2	1	1	1	1	2	13	10	3	9	92
%	1,0	1,0	2,2	46,7	1,0	1,0	2,2	1,0	1,0	1,0	1,0	2,2	14,1	10,9	3,3	9,8	

↑
46.7%

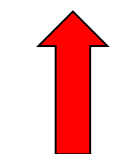
↑
25.0%

Salmonella serotypes isolated in Estonia in 2021

Human cases, Estonian Health Board

Tabel 1. Isoleeritud salmonellade serotüübid, 2021. a

Piirkond	S. Bareilly	S. Bispebjerg	S. Brandenburg	S. Derby	S. Enteritidis	S. Infantis	S. Newport	S. Papuana	S. Stanley	S. Typhimurium	S. Typhimurium monofasne	S. spp	Kokku
Kokku	1	1	1	4	39	1	2	1	1	16	28	19	114
%	0,9	0,9	0,9	3,5	34,2	0,9	1,8	0,9	0,9	14,0	24,6	16,7	



34.2%



38.6%

Salmonella prevalence at the farm level 2016-2020 in Estonia

Year	Pig		Cattle		Broiler Chicken	
	Studied herds ^a	Positive herds (%)	Studied herds ^b	Positive herds (%)	Studied flocks ^c	Positive flocks (%)
2016	17	1 (5.9)	144	2 (1.4)	732	0 (0.0)
2017	25	7 (28.0)	143	5 (3.5)	600	1 (0.2)
2018	22	6 (27.3)	89	3 (3.4)	596	0 (0.0)
2019	29	13 (44.8)	107	3 (2.8)	600	2 (0.3)
2020	26	6 (23.1)	100	6 (6.0)	659	0 (0.0)
Total	119	33 (27.7) 95% CI, 20.1-36.8	583	19 (3.3) 95% CI, 2.0-5.1	3187	3 (0.1) 95% CI, 0.02-0.3

^a Herd level, fattening pigs; samples taken by the Veterinary and Food Board in the framework of the *Salmonella* monitoring programme of Estonia.

^b Samples taken by the Veterinary and Food Board in the framework of the *Salmonella* control programme of Estonia.

^c Samples taken by the Veterinary and Food Board and by the Food Business Operator.

Salmonella positive fattening pig farms in Estonia in 2015-2020

Most prevalent serotypes:
S. Derby (n = 25; 62.5%);
S. Typhimurium incl. m.ST (n = 6; 15%)

Year	Studied farms	No. of positive herds (%)	Related serotypes (No.)
2015	35	4 (11.4)	S. Enteritidis (1) S. Typhimurium (1) S. Lexington (1) S. Infatis (1)
2016	17	1 (5.9)	S. Derby (1) S. Mbandaka (1) - two serotypes detected in the same herd
2017	25	7 (28.0)	S. Cholerasuis (2) S. Derby (4) S. Agona (1) S. Dublin (1) - two serotypes detected in the same herd
2018	22	6 (27.3)	S. Derby (5) S. Agona (1)
2019	29	13 (44.8)	S. Derby (10) Monophasic S. Typhimurium (4) - two serotypes detected in the same herd
2020	26	6 (23.1)	S. Derby (5) S. Typhimurium (1)

Salmonella Control Program in Estonia, Example of pigs

- **Farm/holding level**

- Sampling by veterinary officials. Samples analysed in Veterinary and Food Laboratory.
- Approximately 1/5 of the pig herds/holdings are examined **on a risk-based approach**.
- **Pooled faecal samples** are taken from fattening pigs kept in a group - one pooled sample per 5-10 pigs.
- The number of samples depends on the size of the herd.
- The sampling scheme ensures the detection of the disease at 20% of prevalence with 95% confidence.
- **Restrictions** are applied when herd is declared as *Salmonella*-positive, but only when listed *Salmonella* serotypes are detected (important salmonellosis agents for pigs and regarding relevance to human health)
 - Listed *Salmonella* serotypes for pigs: *S. Enteritidis*, *S. Typhimurium* and its monophasic variant, *S. Derby*, *S. Hadar*, *S. Infantis*, *S. Virchow*, *S. Choleraesuis*.

- **Abattoir level**

- Carcasses before chilling. The abrasive sponge method is used, and samples are taken from the most likely contaminated sites.

- **Meat cutting level**

- At meat cutting level the samples of fresh pork or cuts of fresh pork from a processing line or other suitable place are taken.

- ***Salmonella* control in feed and in animal by-products**



VETERINAAR- JA TOIDUAMET

Salmonelloosi

kontrollprogramm aastateks 2020-
2021



Salmonella prevalence at the slaughterhouse level 2016-2020 in Estonia

Animal species	No. of positive samples / total no. of samples (positive %)					
	2016	2017	2018	2019	2020	Total 95% CI
Pig	12/335 (3.6)	7/403 (1.7)	14/398 (3.5)	15/401 (3.7)	13/370 (3.5%)	61/1,907 (3.2) 2.5-4.1
Cattle	0/211 (0.0)	1/209 (0.5)	0/215 (0.0)	1/214 (0.5)	0/212 (0.0)	2/1,061 (0.2) 0.0-0.8
Broiler chicken	0/16 (0.0)	0/16 (0.0)	0/14 (0.0)	0/12 (0.0)	0/12 (0.0)	0/70 (0.0) 0.0-6.5
Quail	-	-	2/6 (33.3)	2/8 (25.0)	0/8 (0.0)	4/22 (18.2) 6.0-41.0
Total	12/562 (2.1)	8/628 (1.3)	16/633 (2.5)	18/635 (2.8)	13/602 (2.2)	67/3,060 (2.2%) 1.7-2.8

Samples taken within Estonian *Salmonella* Control Program

Carcass surface samples of cattle, swine and sheep (abrasive sponge method)

Poultry neck skin samples

Comparisons of proportions (%) of *Salmonella*-positive single samples from pig carcasses before chilling, by sampler

Country	Competent authorities (CA)					Food business operator (FBOp)					p-value (b)	Interpretation
	Sample weight	N samples Tested	N samples Positive	% samples positive	CI ₉₅	Sample weight	N samples Tested	N samples Positive	% samples positive	CI ₉₅		
Austria						400 cm ²	5,633	5	0.09	[0.03; 0.21]		
Belgium	600 cm ²	1,049	65	6.20	[4.81; 7.83]	600 cm ²	5,055	88	1.74	[1.40; 2.14]	< 0.001	CA > FBOp
Bulgaria	400 cm ²	2,094	0	0.00	[0.00; 0.18] ^(a)	400 cm ²	337	0	0.00	[0.00; 1.09] ^(a)	NS	
Cyprus	400 cm ²	6	0	0.00	—							
Denmark						400 cm ²	10,743	133	1.24	[1.04; 1.46]		
→ Estonia	400 cm ²	401	15	3.74	[2.11; 6.09]	400 cm ²	1,666	2	0.12	[0.01; 0.43]	< 0.001	CA > FBOp
France						400 cm ²	14,409	651	4.52	[4.18; 4.87]		
Germany						400 cm ²	27,269	148	0.54	[0.46; 6.37]		
Ireland	400 cm ²	383	16	4.18	[2.41; 6.70]							
Italy	400 cm ²	6,186	235	3.80	[3.34; 4.31]	400 cm ²	15,786	231	1.46	[1.28; 1.66]	< 0.001	CA > FBOp
Latvia						400 cm ²	606	0	0.00	[0.00; 0.61] ^(a)		
Malta	400 cm ²	60	5	8.33	[2.76; 18.38]	400 cm ²	125	3	2.40	[0.5; 6.85]	< 0.10	CA > FBOp
Netherlands	400 cm ²	383	22	5.74	[3.63; 8.57]						< 0.001	CA > FBOp

Salmonella prevalence at the meat cutting level 2016-2020 in Estonia

Animal species	No. of positive samples / total no. of samples (%)					
	2016	2017	2018	2019	2020	Total 95% CI
Pig	4/250 (1.6)	1/252 (0.4)	3/272 (1.1)	4/276 (1.5)	2/240 (0.8)	14/1,290 (1.1) 0.6-1.9
Cattle	0/106 (0.0)	0/102 (0.0)	1/112 (0.9)	1/120 (0.8)	0/116 (0.0)	2/556 (0.4) 0.1-1.4
Broiler chicken	0/12 (0.0)	0/12 (0.0)	0/16 (0.0)	0/12 (0.0)	0/12 (0.0)	0/64 (0.0) 0.0-1.7
Quail	-	-	-	2/8 (25.0)	0/8 (0.0)	2/16 (12.5) 2.2-39.6
Total	4/368 (1.1)	1/366 (0.3)	4/400 (1.0)	7/416 (1.7)	2/376 (0.5)	18/1,926 (0.9%) 0.6-1.5

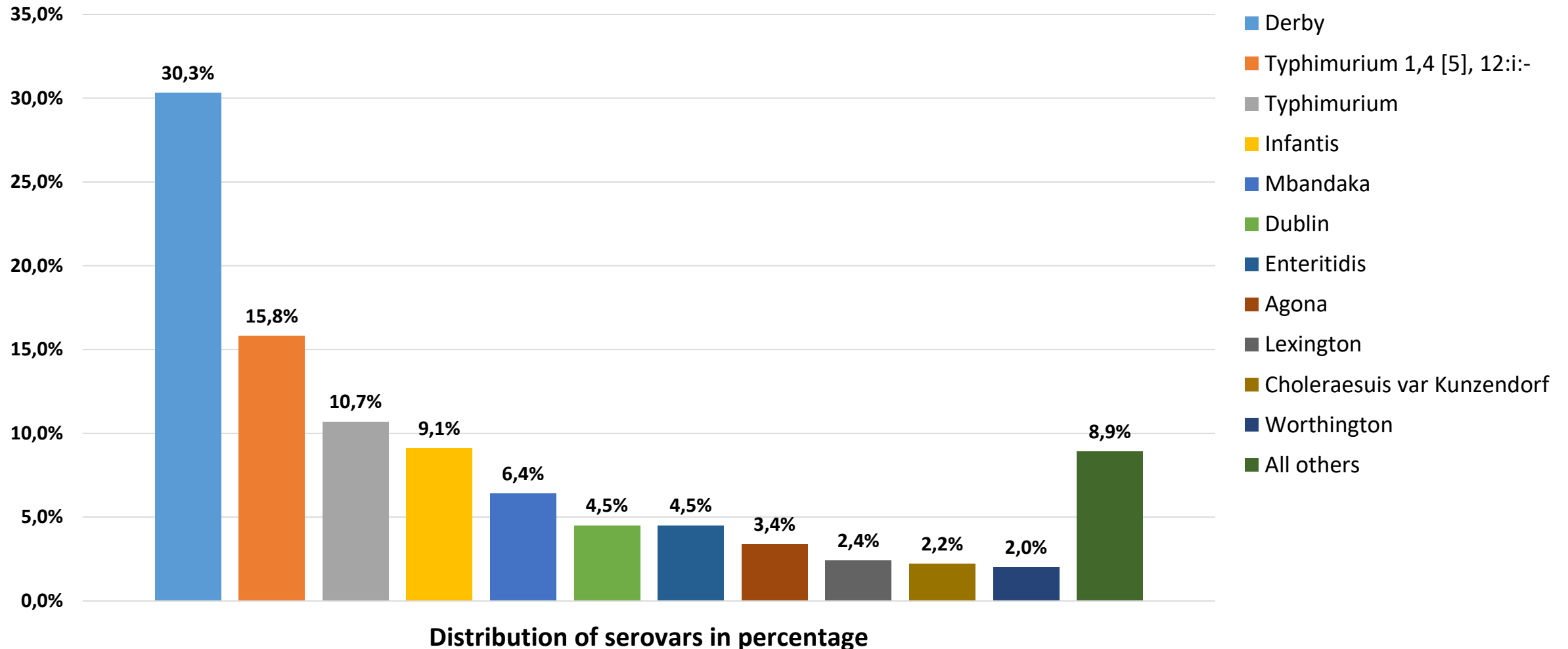
„-“, no samples

Distribution of *Salmonella* serotypes (2016-2020, Estonia)

<i>Salmonella</i> serotype	Slaughterhouse			Meat cutting			In total (%)
	Pig	Cattle	Poultry	Pig	Cattle	Poultry	
Derby	48	0	0	7	0	0	55 (64.7) (CI 95%: 53.5-74.6)
Typhimurium 1,4 [5], 12:i:-	2	0	3*	1	0	2**	8 (9.4) (CI 95%: 4.4-18.2)
Typhimurium	3	0	1*	2	0	0	6 (7.0) (CI 95%: 2.9-15.3)
Infantis	2	0	0	1	0	0	3 (3.5)
Agona	3	0	0	0	0	0	3 (3.5)
Mbandaka	1	0	0	0	1	0	2 (2.4)
Dublin	0	1	0	0	1	0	2 (2.4)
Bredeney	2	0	0	0	0	0	2 (2.4)
Altona	0	1	0	0	0	0	1 (1.2)
<i>Salmonella enterica</i> subsp. <i>enterica</i> (- ; f, g ; -)	0	0	0	3	0	0	3 (3.5)
Total (%)	61 (71.7)	2 (2.4)	4 (4.7)	14 (16.4)	2 (2.4)	2 (2.4)	85 (100)

*Quail
**Quail meat

Serovar distribution of *Salmonella enterica* subsp. *enterica* isolates originated from meat production chain, Estonia (six-year period)



S. Derby is very seldom (~3 cases per year) associated with human *Salmonella* infections

Source: Toomas Kramarenko, Veterinary and Food Laboratory

Salmonella serotypes in humans in Estonia, 2016-2020




Salmonella Serotype	Number of Disease Cases					Total	
	2016	2017	2018	2019	2020		
	(n)	(n)	(n)	(n)	(n)	(n)	(%)
Enteritidis	122	124	213	63	43	565	46.9
Typhimurium	74	78	15	23	13	203	16.8
Infantis	113	6	6	1	1	127	10.5
1,4[5],12:i:-	13	25	13	25	10	86	7.1
Derby	2	3	3	4	2	14	1.2
Java	0	1	4	0	2	7	0.6
Sandiego	0	0	3	0	0	3	0.3
Virchow	0	1	3	2	0	6	0.5
Thompson	3	0	1	0	2	6	0.5
Stanley	1	0	3	0	0	4	0.3
Mbandaka	1	3	0	0	0	4	0.3
Oranienburg	1	0	1	2	0	4	0.3
Coeln	0	2	2	0	0	4	0.3
S. C group	3	2	0	0	0	5	0.4
S. B and D groups	3	3	8	0	3	17	1.4
Salmonella spp.	9	17	24	14	9	73	6.1
All other rare serotypes	13	14	24	20	7	78	6.5
Total (%)	29.7 (n = 358)	23.1 (n = 279)	26.8 (n = 323)	12.8 (n = 154)	7.6 (n = 92)	100.0 (n = 1206)	100.0

Summary

- In 2016-2020, the prevalence of *Salmonella* at the Estonian farm/herd level was 27.7%, 3.3% and 0.1% for fattening pigs, cattle and poultry, respectively.
- The **top three serotypes** isolated at the slaughterhouse and meat cutting levels were ***S. Derby***, **monophasic *S. Typhimurium*** and ***S. Typhimurium***.
- *S. Enteritidis* is the main cause (46.9%) of human salmonellosis cases in Estonia, but in recent years, *Enteritidis* has not been detected at the slaughterhouse or meat cutting level.
- **Conclusion:** In recent years, monophasic ***S. Typhimurium*** has become epidemiologically more important in Estonia, with the second-highest cause in human cases and third-highest among the most prevalent serotypes of *Salmonella enterica* in the Estonian meat chain.
- **Taking into account the high prevalence of *Salmonella*, more attention needs to be paid to the fattening pig farm level in Estonia including educational programs for farmers and verification of the efficiency of the *Salmonella* control measures.**

Article

Prevalence and Serotype Diversity of *Salmonella enterica* in the Estonian Meat Production Chain in 2016–2020

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Abstract: Background: *Salmonella enterica* represents a considerable public concern worldwide, with farm animals often recognised as an important reservoir. This study gives an overview of the prevalence and serotype diversity of *Salmonella* over a 5-year period in the meat production chain in Estonia. Data on human salmonellosis over the same period are provided. Methods: *Salmonella* surveillance data from 2016 to 2020 were analysed. Results: The prevalence of *Salmonella* at the farm level was 27.7%, 3.3% and 0.1% for fattening pigs, cattle and poultry, respectively. *S. Derby* was the most prevalent serotype at the farm level for fattening pigs and *S. Dublin* for cattle. The top three serotypes isolated at the slaughterhouse and meat cutting levels were *S. Derby*, monophasic *S. Typhimurium* and *S. Typhimurium* with proportions of 64.7%, 9.4% and 7.0%, respectively. These serotypes were the top five most common *Salmonella* serotypes responsible for human infections in Estonia. *S. Enteritidis* is the main cause (46.9%) of human salmonellosis cases in Estonia, but in recent years, Enteritidis has not been detected at the slaughterhouse or meat cutting level. Conclusion: In recent years, monophasic *S. Typhimurium* has become epidemiologically more important in Estonia, with the second-highest cause in human cases and third-highest among the most prevalent serotypes of *Salmonella enterica* in the meat chain.

Thank you!

Estonian University of Life Sciences

Agricultural and Food Board of Estonia

Health Board of Estonia

Veterinary and Food Laboratory of Estonia

