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Occurrence and antimicrobial resistance of *Salmonella* spp. isolated from food other than meat in Poland

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Abstract
Introduction and Objectives. Antimicrobial resistance of pathogenic bacteria can result in therapy failure, increased hospitalization, and increased risk of death. In Poland, *Salmonella* spp. is a major bacterial agent of food poisoning. The majority of studies on antimicrobial resistance in *Salmonella* spp. isolates from food have focused on meat products as the source of this pathogen. In comparison, this study examines the antimicrobial susceptibility of *Salmonella* spp. isolated from retail food products other than meat in Poland.
Materials and Methods. A collection of 122 *Salmonella* spp. isolates were isolated in Poland in 2008–2012 from foods other than meat: confectionery products, eggs, fruits, vegetables, spices and others. The resistance of these isolates to 19 antimicrobial agents was tested using the disc diffusion method.
Results. *Salmonella* Enteritidis was the most frequently identified serotype (84.4% of all tested isolates). In total, 42.6% of the *Salmonella* spp. isolates were resistant to antibiotics. The highest frequencies of resistance were observed in isolates from 2009 (60.0%) and 2012 (59.5%). Antibiotic resistance was most prevalent among *Salmonella* spp. isolated from egg-containing food samples (68.0%). Resistance to nalidixic acid was most common and was observed in 35.2% of all tested isolates. The isolates were less frequently resistant to sulphonamides (6.6%), ampicillin (4.9%), amoxicillin/clavulanic acid (2.5%) and to streptomycin, cefoxitin, gentamicin and tetracycline (1.6%). Only one isolate showed resistance to chloramphenicol. Four isolates displayed multiresistance.
Conclusions. Although, the level of resistance and multiresistance of *Salmonella* spp. isolates from non-meat foods was lower than in those from meat products, the presence of these resistant bacteria poses a real threat to the health of consumers.

Key words
antimicrobial resistance, *Salmonella* spp., food, eggs

INTRODUCTION

Salmonella spp. are Gram-negative rod-shaped bacteria that commonly inhabit the intestinal tract of domestic and wild animals. More than 2,600 serovars comprise the *Salmonella* genus [1, 2]. Transmission to humans is mostly associated with the ingestion of food containing bacteria as a result of cross-contamination, direct contact with animals, or a faecally-contaminated environment. Potential contamination problems may be enhanced by inappropriate food storage.

The clinical symptoms of salmonellosis include fever, abdominal pain, diarrhea and vomiting. The severity of the illness depends on the nature of the contaminated food, the infecting dose, and host factors, such as their existing gut flora and immunological condition. More severe salmonellosis occurs in immunocompromised people, the very young and the elderly [3].

Salmonellosis is the second most commonly reported gastrointestinal infection and an important cause of foodborne outbreaks in the European Union/European Economic Area (EU/EEA). Over 100,000 confirmed cases were reported in 2010 and the *Salmonella* spp. serotypes most frequently identified were *S.* Enteritidis (45.0%) and *S.* Typhimurium (22.0%). In 2011, the number of confirmed cases decreased slightly to 95,548 and, as in previous years, S. Enteritidis and S. Typhimurium were the most frequently reported *Salmonella* serotypes (44.4% and 24.9%, respectively) [2, 4].

Antimicrobial resistance of pathogenic bacteria is a serious and growing problem. It can result in therapy failure, increased hospitalization and an increased risk of death. From an economic point of view, it greatly increases the costs of healthcare. Resistance to antibiotics is growing in the EU, especially among Gram-negative bacteria. Each year, about 25,000 patients die in the EU, Iceland and Norway from infections with antibiotic-resistant bacteria; two-thirds being due to Gram-negative bacteria. Infections caused by these resistant bacteria in the EU result in additional healthcare costs and lost productivity, amounting to at least EUR 1.5 billion each year [5, 6, 7].

Antimicrobial resistance is a significant problem for food safety. Trade globalization and the international movement of food products mean that resistant bacteria may spread to consumers all around the world. In addition, horizontal gene transfer can enhance the dissemination of resistant bacteria, which increases the risk that new mechanism of resistance may be transferred via the food chain to the consumer.

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The majority of studies on antimicrobial resistance in *Salmonella* spp. isolates from food have focused on meat products as the source of this pathogen. This is understandable due to the use of antimicrobials in food-producing animals. In comparison, the problem of antibiotic resistance in bacteria isolated from foods other than meat has received little attention.

In addition to meat products, *Salmonella* spp. have also been isolated from eggs, sprouts, spices, fish, cheese, cake, ice cream and other foods. Besides meat, eggs and egg products (e.g. confectionery) are the main sources of *Salmonella*, although the incidence of contamination of these foodstuffs has decreased in recent years. Moreover, recent dietary trends have spread across Europe, including Poland. Increased awareness of a healthy diet has led to a reduction in meat consumption in favour of foods such as fresh fruits and vegetables. The availability and variety of spices is also greater than in the past. As dietary patterns change, it is necessary to consider the microbiological quality of these different foods [8].

The importance of foods other than meat as vehicles of *Salmonella* spp. is confirmed by notifications reported to the RASFF (Rapid Alert System for Food and Feed). RASFF is a tool for control authorities to exchange information about microbiological risks detected in food and animal feed, and the measures taken to respond to these threats [9]. Between 2008–2012, *Salmonella* spp. in products other than meat was responsible, on average, for around 50.0% of notifications in the hazard category 'pathogenic microorganisms' in food.

In the face of the increase in reported *Salmonella* spp. contamination of foods other than meat, it is important to examine the antibiotic resistance profiles of these isolates. The presented study examines the antimicrobial susceptibility of *Salmonella* spp. isolated from retail food products other than meat in Poland between 2008–2012.

MATERIALS AND METHODS

Isolates collection. A total of 122 *Salmonella* spp. isolates was collected by Sanitary and Epidemiological Stations across Poland in the course of their Official Control and Monitoring Programme (14 isolates in 2008, 30 in 2009, 29 in 2010, 12 in 2011 and 37 in 2012). The *Salmonella* spp. were isolated from food other than meat sampled according to PN-EN ISO 6579:2003/A1:2007 'Horizontal method for the detection of *Salmonella spp.*'

Antimicrobial susceptibility testing. The antimicrobial susceptibility of *Salmonella* spp. isolates was assessed by tests performed in 2011 and 2012. The antibiotic resistance profile of each isolate was determined using the disc diffusion method performed on Mueller-Hinton agar (OXOID, PO5007A), according to the methodology of the European Committee on Antimicrobial Susceptibility Testing (EUCAST) [10]. Discs containing the following antibiotics (OXOID) were used: aztreonam (30 µg), amoxycillin/clavulanic acid (20/10 µg), ampicillin (10 µg), cefepime (30 µg), cefotaxime (5 µg), cefoxitin (30 µg), ceftazidime (10 µg), ceftriaxone (30 µg), chloramphenicol (30 µg), ciprofloxacin (5 µg), ertapenem (10 µg), gentamicin (10 µg), imipenem (10 µg), nalidixic acid (30 µg), sulphonamides compound (300 µg), streptomycin (10 µg), tetracycline (30 µg), trimethoprim (5 µg), trimethoprim/sulphametoxazole (1.25/23.75 µg).

Individual colonies were suspended in saline to a density of 0.5 acc. to the McFarland turbidity standard, measured using a densitometer (Biomerieux). Each cell suspension was spread over the entire surface of a plate by swabbing in 3 directions and the antibiotic discs were applied. The plates were then incubated at 35 °C for 16–20 h. The diameters of the zones of inhibition were measured and compared with EUCAST [10] or Clinical and Laboratory Standards Institute (CLSI) standards [11]. In cases where EUCAST breakpoints were absent (nalidixic acid, sulphonamides compounds, streptomycin and tetracycline), the results were interpreted according to the CLSI breakpoints. Quality control tests were performed using *E. coli* ATCC 25922.

***Salmonella* serotyping.** *Salmonella* spp. isolates were serotyped by local Sanitary and Epidemiological Stations. Serotyping was performed by a slide agglutination test with specific O and H antisera (Immunolab, Biomed) and classified according to the White-Kauffmann-Le Minor scheme [1]. Where the serotype of an isolate was undefined, it was determined in the Department of Bacteriology at the National Institute of Public Health–National Institute of Hygiene (NIPH-NIH) in Warsaw, Poland.

Sample categorization. Considering the diversity of foods from which the isolates originated, they were divided into 4 categories:
1) confectionery (cakes with and without cream or custard, after heat treatment and without heat treatment, with additives, e.g. fruits, nuts, etc.);
2) eggs (egg content, eggshell);
3) fruits (fresh or dried), vegetables and spices;
4) other (foods not included in the other 3 categories, e.g. pasta, salad, fish, ice cream).

Statistical analysis. Statistical tests χ^2, χ^2 for trend in proportion, and Fisher's exact test (in the case of small number of isolates) were employed to determine the significance of the observed differences. For all analyses, significance level p=0.05 was assumed. OpenEpi 2.3.1 (http://www.openepi.com) software was used for calculations.

RESULTS AND DISCUSSION

Incidence of *Salmonella* spp. serotypes in various food categories. In total, 122 *Salmonella* spp. were isolated from various foods other than meat products (Tab. 1). *Salmonella* Enteritidis was by far the most frequently isolated serotype (84.4%). Other serotypes were isolated more than once: *S.* Infantis (3.3%), *S.* Newport (3.3%), *S.* Poona (2.5%) and *S.* Typhimurium (1.6%).

The diversity of *Salmonella* spp. serotypes isolated from foods of the 4 defined categories is shown in Table 2. *S.* Enteritidis was the serotype most frequently isolated from confectionery (91.1% of isolates), eggs (84.0%) and other foods (90.0%). Differences in the prevalence of *S.* Enteritidis in this food category were not statistically significant (p>0.05). In samples of plant origin (fruits, vegetables and spices), *S.* Typhimurium and *S.* Newport were most frequently isolated (both 25.0%). Only 8 isolates originated from food samples of this category, but 6 different serotypes were identified.

Table 1. Incidence of *Salmonella* serotypes among isolates from non-meat foodstuffs

Serotype	%	n
Salmonella Enteritidis	84.4	103
Salmonella Infantis	3.3	4
Salmonella Newport	3.3	4
Salmonella Poona	2.5	3
Salmonella Typhimurium	1.6	2
Salmonella Bardo	0.8	1
Salmonella Virchow	0.8	1
Salmonella Singapore	0.8	1
Salmonella Welteweden	0.8	1
Salmonella Rissen	0.8	1
monophasic strain*	0.8	1
Total		**122**

* monophasic *Salmonella enterica* subsp. *enterica* 1,4,12:d:-

Besides *S.* Enteritidis, which was detected in all 4 food categories, 2 other serotypes were also isolated from multiple categories: *S.* Infantis and *S.* Newport were identified in 3 categories. It is noteworthy that *S.* Typhimurium, a prevalent serotype in samples of plant origin (marjoram, cabbage), was not detected in any of the other food categories.

These results are similar to those obtained in some previous studies. Adesiyun et al. [12], and Suresh et al. [13] reported that *S.* Enteritidis was the serotype most frequently isolated from table eggs in Trinidad and eggshell in South India (86.7%), respectively. Notably, these authors also detected 3 serovars, *S.* Cerro, *S.* Mbandaka and *S.* Molade, that were not identified in the present study.

Table 2. Diversity of *Salmonella* spp. serotypes in different categories of non-meat food

Source	Serotype	%	N
Confectionery	Enteritidis	91.1	72
	Poona	3.8	3
	Infantis	1.3	1
	Virchow	1.3	1
	Newport	1.3	1
	Bardo	1.3	1
Total:			**79**
Eggs	Enteritidis	84.0	21
	Infantis	8.0	2
	Newport	4.0	1
	monophasic	4.0	1
Total:			**25**
Fruits, vegetables, spices	Enteritidis	12.5	1
	Typhimurium	25.0	2
	Welteweden	12.5	1
	Rissen	12.5	1
	Newport	25.0	2
	Singapore	12.5	1
Total:			**8**
Other	Enteritidis	90.0	9
	Infantis	10.0	1
Total:			**10**

However, among *Salmonella* spp. serotypes isolated from food samples other than meat taken in Colombia [14], *S.* Enteritidis was not detected. Only *S.* Infantis was isolated, in common with the presented study. The fact that these authors concentrated mostly on isolates from cheese samples may explain this discrepancy (none of the isolates examined in the current study were isolated from cheese).

Salmonella spp. in confectionery originate mainly from eggs. A lack of heat treatment, inadequate heat treatment or cross contamination are the main reasons for the presence of this bacterium in these products. Thus, this problem is mainly associated with home-made products or those from local producers that fail to comply with food hygiene regulations.

In the presented study, the majority of *S.* Enteritidis isolates originated from eggs and egg products. This is in line with the finding that human cases of infection with this *Salmonella* spp. serotype are most commonly associated with the consumption of contaminated eggs [5, 15].

Isolates in food category 3 were isolated from dried apricots (*S.* Enteritidis), pepper (*S.* Welteweden, *S.* Newport), chilli (*S.* Rissen), marjoram (*S.* Typhimurium), cabbage (*S.* Typhimurium), and ground coconut (*S.* Newport, *S.* Singapore). Previous reports describe the isolation of *Salmonella* spp. from similar sources, e.g. pepper, chili and other spices [16, 17].

Antimicrobial susceptibility of *Salmonella* spp. isolates. Of the 19 antimicrobial compounds used in susceptibility testing in this study, incidents of resistance or decreased susceptibility to 10 of them were detected (Tab. 3, Fig. 1). All tested isolates were fully susceptible to aztreonam, cefepime, cefotaxime, ceftriaxone, ciprofloxacin, ertapenem, imipenem, trimethoprim and trimethoprim/sulphametoxazole. No isolate was resistant to ceftazidime, but 2 showed intermediate susceptibility, and only 1 was resistant to chloramphenicol.

The *Salmonella* spp. isolates were most frequently resistant to nalidixic acid (35.2% of all tested isolates). In comparison, resistance to other antimicrobials was less common: 6.6% of isolates were resistant to sulphonamides and 6.6% showed intermediate susceptibility to sulphonamides, 4.9% were resistant to ampicillin, 2.5% were resistant to amoxicillin/clavulanic acid, 1.6% were resistant to streptomycin and 5.7% show decreased susceptibility to streptomycin. Only 2 isolates (1.6%) were also resistant to cefoxitin, gentamicin and tetracycline.

In total, 42.6% of *Salmonella* spp. isolated from foods other than meat in the period 2008 – 2012 showed antibiotic resistance (Fig. 2). The highest percentage of resistant isolates was reported in 2009 (60.0%) and 2012 (59.5%), and the lowest in 2008 (7.1%).

As resistance to nalidixic acid was the most common, the frequency of resistance to this antibiotic in different years was examined (Fig. 3). None of the *Salmonella* spp. isolated in 2008 showed resistance to nalidixic acid. The highest incidence of resistance was observed among isolates from 2009 (57.0%). In 2010 and 2011, the frequency of resistance decreased (28.0% and 17.0%, respectively), while in 2012 it increased again to 43.0% of isolates. The data do not exhibit any systematic trend during the analyzed time period. Quinolone resistance of *Salmonella* spp. is usually associated with point mutations in the quinolone resistance-determining regions (QRDR). The mutations conferring resistance cause amino acid substitutions in the target enzymes of these antibiotics, i.e. gyrase and topoisomerase IV (gyrA, gyrB, parC, parE) [18].

Table 3. Antimicrobial resistance and intermediate susceptibility among different serotypes of *Salmonella* spp. isolated from non-meat foodstuffs (n)
ATM – aztreonam; AMC – amoxycillin/clavulanic ac.; AMP – ampicillin; FEP – cefepime; CTX – cefotaxime; FOX – cefoxitin; CAZ – ceftazidime; CRO – ceftriaxone; C – chloramphenicol; CIP – ciprofloxacin;
ETP – Ertapenem; CN – gentamicin; IPM – imipenem; NA – nalidixic Ac.; SUL – sulphonamides comp.; STR – streptomycin; TE – tetracycline; W – trimethoprim; SXT – trimethoprim/sulphametoxazole

Serotype	No. of isolates	Antimicrobial																		
		ATM	AMC	AMP	FEP	CTX	FOX	CAZ	CRO	C	CIP	ETP	CN	IPM	NA	SUL	STR	TE	W	SXT
Enteritidis	103	0	1I; 2R	4R	0	0	1I; 2R	0	0	0	0	0	2R	0	41R	6I; 3R	1R	1R	0	0
Infantis	4	0	0	0	0	0	0	0	0	0	0	0	0	0	1R	1 I; 2 R	1 I	0	0	0
Newport	4	0	0	0	0	0	0	2I	0	0	0	0	0	0	0	2R	2I	0	0	0
Poona	3	0	0	0	0	0	0	0	0	0	0	0	1 I	0	0	0	1 I	0	0	0
Typhimurium	2	0	1R	1R	0	0	0	0	0	1R	0	0	0	0	0	1R	1 I; 1R	1R	0	0
Bardo	1	0	0	1R	0	0	0	0	0	0	0	0	0	0	1I	0	0	0	0	0
Virchow	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1R	0	0	0	0	0
Singapore	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1I	1I	0	0	0
Welteweden	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rissen	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
monophasic	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1I	0	0	0
Total	122	0	1I; 3R	6R	0	0	1I; 2R	2I	0	1R	0	0	1I; 2R	0	1I; 43R	8I; 8R	7I; 2R	2R	0	0

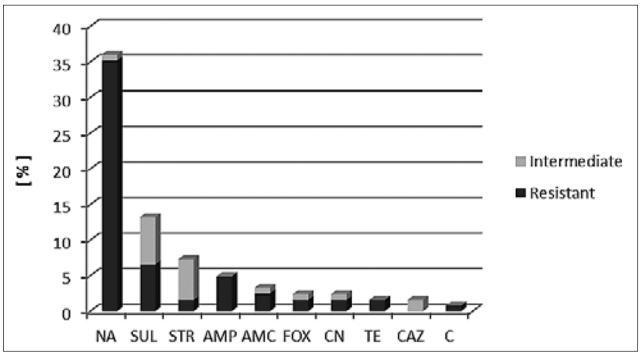

Figure 1. Antimicrobial resistant *Salmonella* spp. isolates

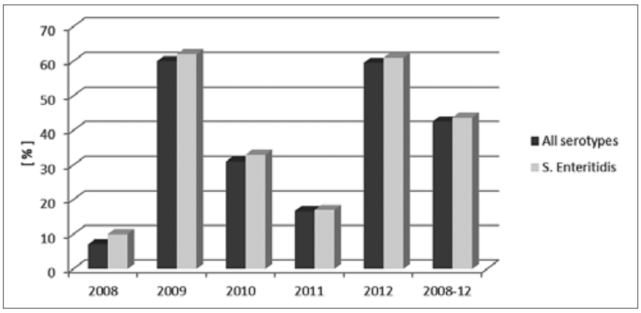

Figure 2. Annual percentages of resistant *Salmonella* spp. of all serotypes compared to *S.* Enteritidis

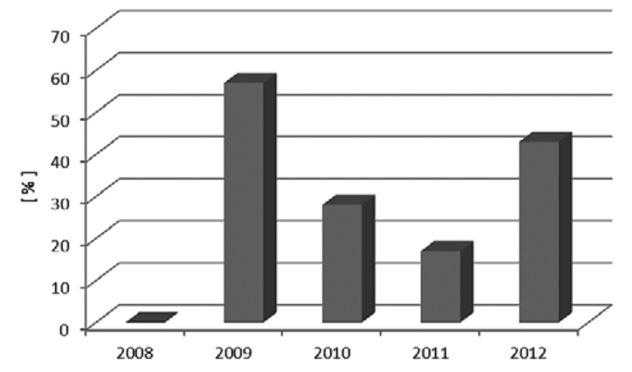

Figure 3. Annual percentages of *Salmonella* spp. resistant to nalidixic acid

If the source of the isolates is considered, 68.0% of them obtained from egg samples during the study period were resistant to antibiotics (Fig. 4). This is considerably higher than the proportion of resistant *Salmonella* spp. isolated from table eggs in Trinidad (22.9%) by Adesiyun et al. [12]. Among all isolates examined in their study, 14.9% were resistant to streptomycin, 6.8% to nalidixic acid, 2.7% to kanamycin and 1.4% to gentamycin [12]. Suresh et al. [13] reported that among 39 *Salmonella* spp. isolated from eggs in south India, all were resistant to ampicillin, neomycin, polymyxin-B and tetracycline.

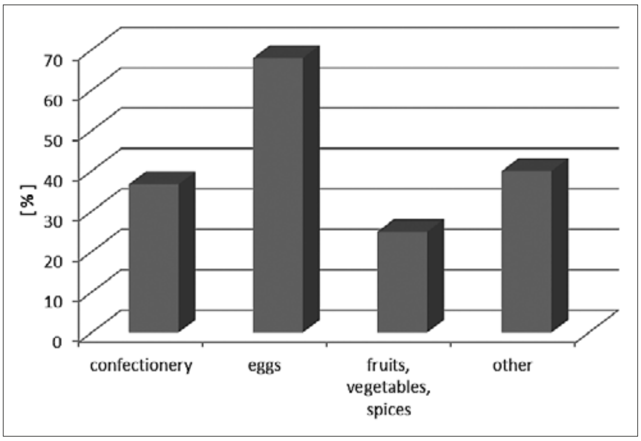

Figure 4. Antimicrobial resistance among *Salmonella* spp. isolated from various sources

Resistance among *Salmonella* spp. isolates obtained from 'confectionery' and 'other sources' were similar, amounting to 36.7% and 40.0%, respectively. Among isolates from 'fruits, vegetables, spices', 25.0% showed antibiotic resistance (results are on the border of statistical significance; p=0.07).

In the study of Van Doren et al. [16] investigating antimicrobial resistance of *Salmonella* spp. in spices, 6.8% of isolates exhibited antimicrobial resistance, of which more than half were resistant to nalidixic acid. Resistance to the following antibiotics was also frequently detected among the isolates: sulfisoxazole (10 resistance /14 resistant isolates), tetracycline (9/14), chloramphenicol (6/14), streptomycin (5/14), kanamycin (4/14) and ampicillin (3/14).

Of *Salmonella* spp. contaminating food imported into the United States, 11.0% were found to be resistant to at least one antimicrobial agent. Resistance to nalidixic acid was observed in only 3.0% of isolates [19]. The most frequently detected resistance was to tetracycline (9.0%), sulfamethoxazole (5.0%) and streptomycin (4.0%).

The antibiotic resistance profile of the isolates tested in the presented study is quite different from that of isolated from retail meats. Among the isolates from meat products from retail in Poland, during the same period of time (2008–2012), resistance to nalidixic acid was prevalent (52.8% of all tested isolates), but tetracycline (32.1%), ampicillin (28.3%), streptomycin (28.3%) and sulphonamides (26.4%) resistance was also common. Both the frequency of resistance to this antimicrobials and the total level of resistance were lower among isolates from food other than meat (42.6% compared to 68.9% of *Salmonella* spp. isolated from meat products) [20]. Among *Salmonella* spp. isolated from retail pork and chicken meat in North Vietnam, resistance to at least one antimicrobial agent was found in 78.4% [21]. The highest frequency of resistance was to tetracycline (58.5%), followed by sulphonamides (58.1%), streptomycin (47.3%), ampicillin (39.8%), chloramphenicol (37.3%), trimethoprim (34.0%) and nalidixic acid (27.8%). A low incidence of resistance to amoxicillin-clavulanic acid (2.1%), norfloxacin (1.2%) and ciprofloxacin (5.0%) was found in such isolates [21]. In China, resistance to sulfamethoxazole, sulfamethoxazole/trimethoprim and nalidixic acid was very common in *Salmonella* spp. isolates from meats [22]. Nalidixic acid resistance was especially prevalent in isolates from chicken meat.

The rate of 57.7% antibiotic resistance detected in *Salmonella* spp. isolated from beef, pork and poultry in Austria is comparable with that found in the presented study [23]. In comparison, among *Salmonella* spp. isolated from chicken carcasses in Italy, 86.1% were resistant to tetracycline, 80.5% were resistant to sulfamethoxazole, and 33.3% were resistant to ampicillin [24].

Antimicrobial resistance of *Salmonella* Enteritidis isolates. Of the 122 *Salmonella* spp. isolates tested in the current study, 103 were *S.* Enteritidis. The occurrence of antibiotic resistance among the isolates of this serotype was analyzed. Because of the prevalence of *S.* Enteritidis, the results are very similar to those obtained when all isolates were considered (Fig. 2). The data do not exhibit any systematic trend (no increase nor decrease). The highest percentage of resistant isolates was observed in 2009 and 2012 (62.0% and 61.0%, respectively). In 2008, 9.7% showed resistance. Overall, 43.7% of the isolated *S.* Enteritidis strains were antibiotic resistant, while 39.8% were resistant to nalidixic acid. Among all resistant *S.* Enteritidis isolates, 91.1% showed resistance to this quinolone. Lower frequencies of resistance to other antimicrobials was detected among the *S.* Enteritidis isolates: 8.9% were resistant to ampicillin, 6.7% to sulphonamides, 4.4% to amoxycillin/clavulanic acid, cefoxitin and gentamicin, and 2.2% to streptomycin and tetracycline.

The study of Campioni et al. [25] included isolates from sources different from those examined in the current study, but resistance to nalidixic acid was also the most common among resistant *Salmonella* Enteritidis isolates (28.1%), and only 0.8% were resistant to trimethoprim-sulfamethoxazole and streptomycin. However, these rates of resistance are lower than those observed in the present study.

Multiresistance. The numbers of isolates exhibiting multiresistance (resistance to 3 or more antimicrobial agents) are shown in Table 4. The vast majority of resistant isolates (82.7%) displayed resistance to one antimicrobial, while only 4 were resistant to 3 or more antimicrobials (3.3% of all tested isolates, 7.7% among resistant isolates); 2 of them were *S.* Enteritidis isolated from cakes in 2010 (one resistant to nalidixic acid, sulphonamides, streptomycin and tetracycline and one resistant to amoxicillin/clavulanic acid, ampicillin, cefoxitin, nalidixic acid), one *S.* Enteritidis isolated from cake in 2012 (resistant to amoxicillin/clavulanic acid, ampicillin and cefoxitin) and one *S.* Typhimurium isolated in 2012 from cabbage salad (resistant to amoxicillin/clavulanic acid, ampicillin, chloramphenicol, sulphonamides, streptomycin and tetracycline).

According to Adesiyun et al. [12], the incidence of multiresistance in *S.* Enteritidis isolated from eggs was 1.4%. Zhao et al. [19], reported that 3.4% of *Salmonella* spp. isolates contaminating food imported to the United States were resistant to more than 3 antimicrobials. Higher percentages (57.0%) of multiresistant *Salmonella* spp. isolates have been observed in other studies [16].

Table 4. Multiresistance of *Salmonella* spp. isolates

Serotype	No. of antimicrobials					
	1	2	3	4	5	6
Salmonella Enteritidis	38	4	1	2		
Salmonella Infantis	1	1				
Salmonella Newport	2					
Salmonella Poona						
Salmonella Typhimurium						1
Salmonella Bardo	1					
Salmonella Virchow	1					
Salmonella Singapore						
Salmonella Welteweden						
Salmonella Rissen						
monophasic strain*						
Total:	**43**	**5**	**1**	**2**	**0**	**1**

CONCLUSIONS

The main serotype of *Salmonella* spp. isolated from foods other than meat in Poland between 2008–2012 was *S.* Enteritidis.

Of the antibiotic resistant isolates identified, the great majority showed resistance to only one antimicrobial agent. Among the isolates, resistance to nalidixic acid was most prevalent, while resistance to sulphonamides and tetracycline was observed in a small percentage.

The presented results reveal that there are differences between the antimicrobial resistance profiles of *Salmonella* spp. isolated from meat products and those from other foods. The percentage of resistant and multiresistant isolates appears to be lower than among isolates isolated from meat products.

However, this does not change the real threat to the health of consumers.

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