

## Prevalence and antimicrobial resistance patterns of *Salmonella* spp. isolated from different aged pigs in Korea

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**Abstract :** A total of 114 *Salmonella* spp. (17.90%) were isolated from 637 fecal swab samples collected in October 2005 and they were from 25 (78.13%) of 32 farms investigated nation-widely in Korea. *Salmonella* spp. from age group of 30-, 60-, 90-, 120-day olds were 17.61%, 16.98%, 15.72%, and 21.25%, respectively. Nine serovars of *Salmonella* spp. were identified. The predominant serovars of isolates were *S. Typhimurium* (including var Copenhagen), *S. Agona*, *S. Derby*, and *S. Heidelberg* by turns. Almost isolates belonged to serogroup B (69.30%). All isolates were resistant to penicillin G and oxytetracycline, and this was considered due to be used as feed additive through the most of pig farms for decades. And also, frequent resistance observed for ampicillin, sulfamethoxazole-trimethoprim, and lincomycin-spectinomycin, which are commonly used in veterinary medicine for decades, indicates an urgent need to utilize these antimicrobials more prudently if their benefits are to be preserved.

**Key words:** antibiotic resistant, prevalence, *Salmonella* spp., serovars

*Salmonella enterica* is one of many enteric disease-causing agents in humans and other animals. *Salmonella* spp. are zoonotic and often foodborne bacteria; major reservoirs for human infection are believed to be livestock and poultry [1, 10, 11, 16]. *Salmonella* spp. is frequently isolated from the environment and livestock of pig farms. *Salmonella* infections of swine are of concern for two major reasons. The first is the clinical disease (Salmonellosis) in swine that may result, and the second is that swine can be infected with a broad range of *Salmonella* serotypes that can be a source of infection of pork products [6]. Although many of the more than 2,400 *Salmonella* serotypes have a broad host range and are widely distributed, several serotypes are quite adapted to a single host species, most notably *S. typhi* (humans), *S. dublin* (bovine), and *S. choleraesuis* (swine). Many serotypes are not associated with overt disease and appear to have limited host and geographical range. The use of antimicrobial agents in human and animals can lead to the emergence of antimicrobial resistant bacteria [2]. The frequency

of multi-drug resistance within *Salmonella* strains isolated from zoonotic foodborne infections are increasing.

Due to strong link between human and pigs, many reports containing estimates of the prevalence of *Salmonella* spp. have in fact compiled epidemiological data from slaughterhouse or carcasses [4, 9, 15]. But, the overall stream of *Samonella* spp. in the swine farm unit is rarely published. Therefore, the objective of the study was to evaluate serovar and antimicrobial resistance patterns of *S. enterica* isolated from pigs of different age groups in Korean swine herds.

Thirty-two swine farms joined the Hazard Analysis Critical Control Point (HACCP) program for Korean swine farms were selected in October 2005 for this study. The farms are distributed in all over Korea and the informations about herd size and clinical sign were blind. Approximately 5 fecal swab samples per age group were collected randomly from each farm. The age groups are as follows: 30-, 60-, 90-, and 120-day-old pigs. And the samples were committed to the animal

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virology lab of Seoul National Univ. for isolation of *Salmonella* spp. Isolation of *Salmonella* spp. was performed by conventional methods [5]. Briefly, samples incubated in 10 ml of Rappaport-Vassiliadis (RV, Difco, USA) broth at 43°C for 24 h. Ten microliter of the RV mixture was streaked onto xylose-lysine-deoxycholate (Komed, Korea) agar plates and incubated at 37°C. After 48 h, the plates were examined for the presence of presumptive *Salmonella* colonies, and the suspected colonies were streaked onto bismuth sulphate agar (Difco, USA) plates, and then biochemical tests were performed including triple sugar iron (Difco, USA) test.

According to ranking of frequency of isolation from swine sources, plans for the identification of ten serotypes were organized [6]. To identify serotypes, serum agglutination test were performed using O antigen and H antigen antisera (Difco, USA) of *Salmonella* spp.

After being confirmed as *Salmonella* spp., the isolates

were screened for antimicrobial susceptibility by disk-diffusion method. The antimicrobial susceptibility test was performed against lincomycin/streptomycin, ceftiofur, gentamicin, oxytetracycline, penicillin G, ampicillin, and sulfamethoxazol/trimethoprim (Oxoid, UK), which are usually used in Korean conventional swine farms.

A total of 114 *Salmonella* spp. (17.90%) were isolated from 637 fecal swab samples and they were from 25 farms (78.13%) of 32 investigated farms. Prevalence of *Salmonella* spp. from age group of 30-, 60-, 90-, 120-day olds were 17.61%, 16.98%, 15.72%, and 21.25%, respectively (Table 1). Nine serovars of *Salmonella* spp. were identified as shown in Table 2. The predominant serovars of isolates were *S. Typhimurium* (including var Copenhagen), *S. Agona*, *S. Derby*, and *S. Heidelberg* by turns (Table 3). Almost isolates belonged to serogroup B (69.30%).

Isolates were grouped into antimicrobial resistance

**Table 1.** Prevalence of *Salmonella* spp. in different age groups

Age	No. of fecal samples	No. of positive samples (%)	No. of tested herds	No. of positive herds (%)
30 days	159	28 (17.61)	32	16 (50.00)
60 days	159	27 (16.98)	32	13 (40.63)
90 days	159	25 (15.72)	32	14 (43.75)
120 days	160	34 (21.25)	32	14 (43.75)
Total	637	114 (17.90)	128	57 (44.53)

**Table 2.** Antimicrobial resistance clusters (ARCs) on the basis of patterns of 7 antimicrobials

ARCs	No. of antimicrobials to which the isolates were resistant	Antimicrobials							No. of <i>Salmonella</i> isolates belonging to susceptibility clusters	Frequency of <i>Salmonella</i> isolates according to No. of antimicrobial resistance
		OT	P	Amp	SXT	LS	CN	Cef		
A	3	-	-	-	+	+	+	+	2	2 (1.75%)
B	4	-	-	-	+	-	+	+	4	
C	4	-	-	+	-	-	+	+	4	
D	4	-	-	-	+	+	-	+	1	20 (17.54%)
E	4	-	-	+	-	+	-	+	3	
F	4	-	-	-	-	+	+	+	8	
G	5	-	-	-	+	-	-	+	5	
H	5	-	-	+	-	-	-	+	1	27 (23.68%)
I	5	-	-	-	-	-	+	+	12	
J	5	-	-	-	-	+	-	+	9	
K	6	-	-	-	-	-	-	+	65	65 (57.02%)
Frequency of <i>Salmonella</i> isolates resistant to each antimicrobials		114 (100%)	114 (100%)	106 (92.98%)	102 (89.47%)	93 (81.58%)	82 (71.93%)	0 (0%)		114

OT = Oxytetracycline, P = Penicillin G, Amp = Ampicillin, SXT = Sulfamethoxazole-trimethoprim, LS = Lincomycin-Spectinomycin, CN = Gentamicin, Cef = Ceftiofur.

**Table 3.** Frequency of *Salmonella enterica* serovars and their antimicrobial resistance clusters (ARCs) distribution

Serogroup	<i>Salmonella</i> serovars	No. of isolates	ARCs										
			A	B	C	D	E	F	G	H	I	J	K
B	Typhimurium	5	-	-	-	1	1	1	-	-	-	-	2
	Typhimurium var Copenhagen	17	1	1	1	-	-	-	1	-	1	-	12
	Agona	25	1	-	1	-	-	2	-	-	4	5	12
	Derby	12	-	1	-	-	-	-	2	-	1	1	7
	Heidelberg	12	-	-	-	-	1	1	-	-	1	1	8
	Schwarzengrund	8	-	-	-	-	1	-	-	1	-	1	5
	Choleraesuis	3	-	-	-	-	-	1	-	-	-	-	2
C <sub>1</sub>	Choleraesuis var Kunzendorf	9	-	2	-	-	-	2	-	-	1	-	4
	Mbandaka	10	-	-	-	-	-	-	-	-	2	1	7
E <sub>1</sub>	Anatum	0	-	-	-	-	-	-	-	-	-	-	-
	Untypable	13	-	-	2	-	-	1	2	-	2	-	6
Total number of isolates		114	2	4	4	1	3	8	5	1	12	9	65

clusters (ARCs) on the basis of patterns of 7 antimicrobials (Table 2). All isolates were resistant to oxytetracycline and penicillin G, and resistant to ampicillin (92.98%), sulfamethoxazol/trimethoprim (89.47%) and lincomycin/ streptomycin (81.58%) were followed. Sixty-five isolates (57.02%) were resistant to all tested antimicrobials except ceftiofur.

There are some papers about *Salmonella* spp. infection of swine farms in Korea and their antimicrobial susceptibilities [3, 7, 13]. The prevalence of *Salmonella* spp. was slightly different from our data due to the targeted organs, investigated season and years, and sampled age groups. Also, the data must be influenced by high health status of swine farms involved in the program of HACCP. Therefore, the prevalence of this study was lower than data in previous reports that mostly investigated [8, 12, 14]. The distribution of *Salmonella* spp. was widespread in the different age groups. It was considered to be endemic infection cycles in most Korean farms. All isolates were resistant to penicillin G and oxytetracycline, and this was considered due to using those as feed additive through the most of swine farms for decades. And also, frequent resistance observed for antimicrobials, sulfamethoxazole-trimethoprim, lincomycin-spectinomycin, which are commonly used in veterinary medicine for decades, indicates an urgent need to utilize these antimicrobials more prudently if their benefits are to be preserved. And the significant differences of ARCs among different ages were not shown. It was guessed that the source of multi-resistant

*Salmonella* spp. from young pigs was most likely to be sows or environment such as feed, water, and other animals. Furthermore, the risk factors associated with the presence of multiple antimicrobial-resistant *Salmonella* spp. will be investigated, and it will be thought the need of regulation of antimicrobials not only in fattening pigs but also in overall pig unit.

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