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Prevalence of Antibiotic Resistant Foodborne Bacteria Isolated in Korea

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Abstract This study was performed to determine the antibiotic susceptibility profiles of *Salmonella* spp., coliforms, *Listeria monocytogenes*, *Staphylococcus aureus* and *Vibrio* spp. isolated from broiler carcasses, aquacultured flounders, hamburgers, and lettuce, which are foods consumed in large quantities in Korea. *Salmonella* spp. and *L. monocytogenes* were isolated only from broiler carcasses and *Salmonella* spp. had a high multidrug resistance rate of 61.1%. Meanwhile, coliforms and *S. aureus* were isolated from all four foods tested in this experiment. The multidrug resistance rate of coliforms from broiler carcasses was 50%, and that of *Vibrio* spp. from flounders was 71.4%. The resistance to tetracycline, streptomycin, ampicillin or carbenicillin was common regardless of the kind of food or isolate.

Keywords: Antibiotic susceptibility, *Salmonella* spp., *L. monocytogenes,* Coliforms, *S. aureus*

Introduction

Foodborne illness is an important public health problem in most countries, in spite of the improvement in hygiene, food processing, education of food handlers and information to consumers. In addition to the problem of foodborne illness, antibiotic resistance is a growing concern. Antibiotics have been widely used in animals as veterinary drugs or as growth promoters. About 99% of veterinary antibiotic use is for farm animals and 1% for pets. The antibiotics are currently used to treat or prevent bacterial infections in animals. The large use of antibiotics may have contributed to the emergence and spread of resistance in the environment and in humans (1-3).

Despite large differences in methodology, most retrospective and prospective studies show that after the introduction of an antibiotic, the level of resistance of pathogenic bacteria and commensal bacteria increases. Soon after the introduction of antibiotics, antibiotic resistance genes appear not only in the animal's bacteria but also in the commensal flora of humans. This occurs for zoonotic pathogens like salmonellae, and strictly human pathogens, like shigellae. Because the human and animal microbial ecosystems are inextricably interwound, microbial antibiotic resistance readily crosses boundaries (4, 5).

Monitoring the prevalence of antibiotic resistance in indicator bacteria such as fecal *Escherichia coli* and *Enterococci* in different populations makes it feasible to compare the prevalence of antibiotic resistance and to detect the transfer of resistant bacteria or resistant genes from animals to humans and vice versa. There are some reports in which antibiotic susceptibility of pathogens from humans and animals have been studied. However, there are fewer studies of antibiotic resistance of bacteria associated with specific food (5, 6).

The objective of this study was to investigate the presence of *Salmonella* spp. *L. monocytogenes*, *S. aureus* and *Vibrio* spp., and to obtain a representative picture of the prevalence of antibiotic resistant bacteria isolated from several foods in Korea. It was also aimed to establish a baseline for comparison in further studies.

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Materials and Methods

Samples Samples were divided into two groups. The first group of broiler carcasses and aquacultured flounders was exposed to a high level of antibiotics during production. The second group of hamburgers and lettuce was exposed to a low level of antibiotics. Fresh broiler carcasses, aquacultured flounders and lettuce were purchased from supermarkets and conventional markets in Seoul and the suburban area. Hamburgers were purchased from fast food restaurants in Seoul, Korea. One hundred food samples were collected, transferred to an ice cooler immediately after sampling and tested upon arrival.

Isolation and identification Fresh broiler carcasses, aquacultured flounders, lettuce and hamburgers were analyzed for coliforms, *Salmonella* spp. *Listeria monocytogenes* and *Staphylococcus aureus*. *Vibrio* spp was analyzed only in flounders. Isolation of microorganisms was done according to the FDA Bacteriological Analytical Manual and with the USDA Microbiology laboratory guidebook (7, 8).

***Salmonella* spp.**: A whole chicken carcass rinse sampling procedure was used for broiler carcasses. The entire carcass was transferred to a sterile stomacher bag containing 500 mL of saline. The carcasses in the bag were then shaken by a rocking motion for 1 min. Twenty-five milliliters of rinsed saline was transferred to buffered peptone water (BPW) and incubated for 18 hr at 35-37°C for the isolation of *Salmonella* spp.. Twenty-five grams of flounder, hamburger and lettuce were stomached with 225 mL of BPW. After incubation, 1 mL of incubated BPW was inoculated into Rappaport-Vassiliadis (RV) broth and incubated for 6-8 hr at 42°C. One milliliter of incubated BPW was also inoculated into Selenite Cysteine (SC) broth and incubated for 18 hr at 37°C. One loop of sample was transferred from each tube to SM ID plate (bioMerieux Inc., Marcy lEtoile, France.), Bismuth sulfite and Hektoen enteric plate and streaked for isolation. The agar plates were incubated for 24-48 hr at 36-37°C. One milliliter of sample from RV and SC broth was transferred to M broth for the screening of *Salmonella* by using VIDAS SLM (bioMerieux Inc., Marcy l'Etoile, France). Presumptive *Salmonella* colonies were transferred to Kligler iron agar, urea agar and lysine iron agar slant and were incubated at 35°C for 24 hr. Five presumptive colonies were chosen from each plate and these isolates were screened by Gram staining and the Vitek Microbe ID system (Vitek-JR, bioMerieux Inc., Marcy lEtoile, France). *Salmonella* spp. were confirmed and identified by serotyping and antisera (Difco, Detroit, Mich.).

***Listeria monocytogenes*:** Twenty-five grams of each sample were aseptically taken, and blended for 2 min in 225 mL of UVM modified *Listeria* enrichment broth (Difco, Detroit, Mich.), and incubated for 24 hr at 30°C. One milliliter of the enrichment broth was transferred into 9 mL of Fraser broth containing ferric ammonium citrate for a second enrichment and incubated for 24-72 hr at 30°C. Fraser broth was streaked to modified Oxford agar, and plates were examined for typical *Listeria* colonies after 24-72 hr incubation at 30°C. Biochemical tests, including Gram staining, carbohydrate utilization, β-hemolysis, motility, CAMP test, an API-*Listeria* kit (bioMerieux Inc., Marcy l'Etoile, France), and Vitek Microbe ID system (bioMerieux Inc., Marcy l'Etoile, France), were used to confirm the differences between *Listeria* spp. and *L. monocytogenes*.

Coliforms: After blending 25 g of sample with 225 mL of BPW, the homogenate was transferred to EC broth and incubated for 24-26 hr at 44.5°C for the isolation of coliforms. EC broth was streaked to a Coli ID plate (bioMerieux Inc., Marcy l'Etoile, France). Suspected colonies were streaked to nutrient agar and identified using Gram staining and the Vitek Microbe ID system.

***Staphylococcus aureus*:** Tryptic soy broth with 10% NaCl was used for the enrichment of *S. aureus*. After 16-18 hr incubation at 35-37°C, one loop of sample was transferred to Baird-Parker RPF (bioMerieux Inc., Marcy lEtoile, France). Biochemical tests, including Gram staining, coagulase, b-hemolysis, and catalase test were performed and *S. aureus* was identified using Vitek Microbe ID system.

***Vibrio* spp.:** Twenty-five grams of flounders were added to alkaline peptone water with 2% NaCl and incubated for 18-24 hr at 37°C. After incubation, alkaline peptone water was streaked into thiosulfate-citrate-bile salts-sucrose (TCBS) agar and incubated for 18-24 hr at 37°C. For the presumptive differentiation, a TSI slant was used and Gram staining was performed. The Vitek Microbe ID system was used for identification.

Antibiotic susceptibility test: Isolates were tested for sensitivity to antibiotics by the disk diffusion method using Muller-Hinton agar (Difco). NaCl (3%) was added into Muller-Hinton agar for *Vibrio* spp. and Tryptic soy agar was used for *L. monocytogenes*. Sensi-Disc Antimicrobial Susceptibility Test Disc (BBL Microbiology Systems, Cockeysville, MD) was used and the concentrations of the antibiotics were 10 μg ampicillin, 30 μg amikacin, 30 μg chloramphenicol, 100 μg carbenicillin, 30 μg cephalothin, 5 μg ciprofloxacin, 15 μg erythromycin, 10 μg gentamicin, 10 μg tobramycin, 10 U penicillin, 10 μg streptomycin, 23.75 μg sulfamethoxazole-1.25 μg trimethoprim, 30 μg tetracycline, 1 μg oxacillin, 10U bacitracin, 300U polymyxin B, 300 μg nitrofurantoin, 2 μg clindamycin, 5 μg rifampin, and 30 μg vancomycin. Results were recorded by measuring the inhibition zone diameter and were scored as sensitive, intermediate and resistant according to the National Committee for Clinical Laboratory Standard recommendations. *E. coli* ATCC 25922 and *S. aureus* ATCC 25923 were used as reference strains (9).

Results and Discussion

Prevalence of bacteria from foods: The incidences of foodborne bacteria from broiler carcasses, aquacultured flounders, hamburgers and lettuce are shown in Tables 1 and 2. *Salmonella* spp. and *L. monocytogenes* were isolated from 32% and 48% of broiler carcasses, respectively, but were not isolated from other foods (Table 1). Among the 4 serotypes of *Salmonella* detected, *S.* Enteritidis was the most common, followed by *S.* Haardt, *S.* Tennessee and *S.* Agona (Table 2). Several researchers investigated the prevalence of *Salmonella* spp. from various foods and environments, and isolated different serotypes of *Salmonella* strains (10-13). In Korea, the prevalence of *Salmonella* spp. from broiler carcasses is reported as 25.9% and 37% (14, 15). Other studies have shown a higher prevalence rate of *Salmonella* spp., with *S.* Enteritidis being the most frequently encountered serotype (13, 16-18). Six different serotypes from chicken carcasses in Greece were isolated, with *S.* Enteritidis being the most common and accounting for 41.9% of the isolates. In Great Britain and various European countries, *S.* Enteritidis accounts for more than 60% of *Salmonella* spp. from human cases (19-21).

Coliforms were isolated from all broiler carcasses, 48% of aquacultured flounders, 52% of hamburgers and 96% of lettuce. *S. aureus* was isolated from 60% of broiler carcasses,

Table 1. Incidence of foodborne bacteria in 4 types of foods

Microorganisms	Percentage of positive samples (No. of isolates)			
	Broiler carcasses	Aquacultured flounders	Hamburgers	Lettuce
Salmonella spp.	32(18)	0(0)	0(0)	0(0)
Coliforms	100(26)	48(14)	52(13)	96(24)
S. aureus	60(23)	12(3)	12(3)	52(19)
L. monocytogenes	48(28)	0(0)	0(0)	0(0)
Vibrio spp.	- *	56(28)	-*	-*

*These foods were not tested for *Vibrio* spp.

Table 2. Bacteria isolated from broiler carcasses, aquacultured flounders, hamburgers, and lettuce

Source (No. of samples)	Coliforms	*Salmonella* spp.	*L. monocytogenes*	*S. aureus*	*Vibrio* spp.
	(No. of isolates)				
Broiler carcasses (25)	*Citrobacter freundii*; 5 *Escherichia coli*; 17 *Enterobacter cloacae*; 1 *Serratia liquefaciens*; 1 *Citrobacter braakii*; 1 *Klebsiella ozaenae*; 1	*S.* Enteritidis ; 11 *S.* Tennessee ; 1 *S.* Agona ; 1 *S.* Haardt ; 5	28	23	-[1)]
Aquacultured flounders (25)	*Citrobacter braakii*; 2 *Enterobacter amnigenus*; 1 *Enterobacter cloacae*; 7 *Klebsiella pneumoniae*; 4	ND[2)]	ND	3	*V. alginolyticus*; 19 *V. parahaemolyticus*; 9
Hamburgers (25)	*Klebsiella pneumoniae*; 13	ND	ND	3	-[1)]
Lettuce (25)	*Klebsiella pneumoniae*; 15 *Enterobacter cloacae*; 6 *Escherichia coli*; 3	ND	ND	19	-[1)]

[1)]These foods were not tested for *Vibrio* spp.
[2)]Organism was not detected in this food

and 52% of lettuce (Table 1). *E. coli* was isolated from 68% of broiler carcasses (Table 2). Among the coliforms isolated from flounders, 7 isolates of *Enterobacter cloacae* and 4 of *Klebsiella pneumoniae* were identified. *Klebsiella pneumoniae* was the predominant coliform isolated from hamburgers (52%) and lettuce (60%). According to Soriano *et al.*, Enterobacteriaceae are detected with high incidence, and *E. coli* and *Klebsiella pneumoniae* are detected from 10% of raw lettuce in Spain (22). In Taiwan, the incidence of *E. coli* and coliforms in the vegetarian food products are 29% and 33%, respectively (23).

Aquacultured flounders were also tested for the prevalence of *Vibrio* spp., which were isolated from 56%; 68% were identified as *V. alginolyticus* and 32% as *V. parahaemolyticus*. *Vibrio* spp. were isolated in 19.65% of sea fish and shrimp from the Adriatic Sea and *V. parahaemolyticus* is the most frequently found isolate (24).

Antibiotic susceptibility of *Salmonella* spp., coliforms and *Vibrio* spp.: The susceptibility of the gram negative isolates to 14 antimicrobial agents is shown in Table 3. *Salmonella* spp. showed the highest resistance rate, at 83.3% to ampicillin, 77.8% to streptomycin and carbenicillin, and 61.1% to tetracycline. *Salmonella* isolates from patients or animal fecal samples are resistant to antimicrobial agents such as ampicillin, chloramphenicol, streptomycin and trimethoprim/sulfamethoxazole (4, 25). All *Salmonella* isolates were sensitive to gentamicin, amikacin, tobramycin, colistin, polymyxin B, ciprofloxacin, and trimethoprim/sulfamethoxazole. Coliforms from broiler carcasses showed resistance to most antibiotics, with the rates of resistance to tetracycline, streptomycin, ciprofloxacin and ampicillin being 92.3%, 76.9%, 57.7% and 53.8%, respectively. Resistance to amikacin, colistin or polymyxin B was not detected. *E. coli* from animals or animal foods is most commonly resistant to tetracycline and also to ciprofloxacin, gentamicin and trimethoprim/sulfamethoxazole (5, 26). Over 90% of coliforms from lettuce and hamburgers were resistant to ampicillin and most also showed resistance to carbenicillin. The rate of resistance of coliforms isolated from flounders to ampicillin, cephalothin and carbenicillin was 78.6%, 50.0% and 28.6%, respectively. *Vibrio* spp. from flounders also showed resistance to most of the antibiotics tested in this study and all of *Vibrio* spp. from flounders were resistant to ampicillin and carbenicillin. The resistance rate to cephalothin, amikacin and streptomycin was 96.4%, 71.4%, and 46.4%, respectively. It should be noted that *Vibrio* spp. from aquacultured flounders showed higher intermediate resistance rate than *Salmonella* spp. or coliforms from other foods; 85.7% of *Vibrio* spp. showed intermediate resistance to tetracycline, 82.1% to ciprofloxacin and 67.9% to tobramycin.

Antibiotic susceptibility of *S. aureus* and *L. monocytogenes*: Table 4 shows the antibiotic susceptibility of Gram positive pathogens. Most of the *S. aureus* isolated in this study were resistant to penicillin, tetracycline and ampicillin, but all were sensitive to oxacillin, chloramphenicol, amikacin, vancomycin, bacitracin, cephalothin, rifampin and trimethoprim/sulfamethoxazole. Among *S. aureus* from broiler carcasses, the resistance rates to tetracycline and penicillin were 73.9 % and 39.1%, respectively. Also, 84.2% of *S. aureus* from lettuce were resistant to penicillin and ampicillin, and 52.6% were resistant to erythromycin. Other studies in Korea have shown a similar antibiotic resistance pattern of *S. aureus* isolated from foods and patients. *Staphylococcus* spp. isolated from dairy milk in Korea are resistant to vancomycin (51%), ampicillin (49%) and penicillin (47 %), and 49% of isolates are resistant to more than two antibiotics (27). Among Korean patients, 38.1% of *S. aureus* isolates are resistant to penicillin, and 46% have at least one antibiotic resistance (28). In Taiwan, 51% of *S. aureus* isolates from food are resistant to penicillin but no methicillin-resistant *S. aureus* (MRSA) strains could be found among the food isolates (29). *L. monocytogenes* isolated from broiler carcasses was resistant to several antibiotics with resistance rates to tetracycline and nitrofurantoin of 42.9% and 32.1%, respectively (Table 4). Other studies in Korea show that *Listeria* isolates from animal foods and environments have a similar resistant rate to tetracycline (30, 31).

The patterns of multidrug resistance: Multiple resistances to more than four antibiotics were observed (Table

Table 3. Antibiotic susceptibility of *Salmonella* spp., coliforms, and *Vibrio* spp.

Microbial Isolates	Source	Susceptibility (%)[1]	Antibiotics[2]													
			Te	C	S	GM	AN	NN	CL	PB	F/M	AM	CB	CF	SXT	CIP
Salmonella spp.	Broiler carcasses	R	61.1	22.2	77.8	0	0	0	0	0	22.2	83.3	77.8	0	0	0
		I	0	5.6	11.1	0	0	0	0	0	11.1	0	0	27.8	0	0
		S	38.9	72.2	11.1	100	100	100	100	100	66.7	16.7	22.2	72.2	100	100
Coliforms	Broiler carcasses	R	92.3	3.8	76.9	15.4	0	3.8	0	0	3.8	53.8	38.5	19.2	42.3	57.7
		I	0	0	7.7	0	0	3.8	0	0	30.8	23.1	0	23.1	0	23.1
		S	7.7	96.2	15.4	84.6	100	92.3	100	100	65.4	23.1	61.5	57.7	57.7	19.2
	Lettuce	R	4.2	0	4.2	4.2	0	4.2	0	0	0	91.7	62.5	25.0	4.2	0
		I	0	0	0	0	0	0	0	0	4.2	8.3	0	0	0	0
		S	95.8	100	95.8	95.8	100	95.8	100	100	95.8	0	37.5	75.0	95.8	100
	Hamburgers	R	0	0	0	0	0	0	0	7.7	0	92.3	92.3	0	0	0
		I	0	0	0	0	0	0	0	0	7.7	7.7	0	0	0	0
		S	100	100	100	100	100	100	100	92.3	92.3	0	7.7	100	100	100
	Aquacultured flounders	R	14.3	0	0	7.1	0	0	0	0	0	78.6	28.6	50.0	0	0
		I	0	0	21.4	0	0	0	0	0	0	14.3	0	14.3	0	0
		S	85.7	100	78.6	92.9	100	100	100	100	100	7.1	71.4	35.7	100	100
Vibrio spp.	Aquacultured flounders	R	3.6	0	46.4	0	71.4	21.4	35.7	3.6	10.7	100	100	96.4	7.1	3.6
		I	85.7	0	46.4	42.9	21.4	67.9	42.9	50.0	50.0	0	0	0	7.1	82.1
		S	10.7	100	7.1	57.1	7.1	10.7	21.4	46.4	39.3	0	0	3.6	85.7	14.3

[1]R; resistant I; intermediate S; sensitive
[2]Te; Tetracycline, C; Chloramphenicol, S; Streptomycin, GM; Gentamicin, AN; Amikacin, NN; Tobramycin, CL; Colistin, PB; polymyxin B, F/M; Nitrofurantoin, AM; Ampicillin, CB; Carbenicillin, CF; Cephalothin, SXT; Trimethoprim/Sulfamethoxazole, CIP; Ciprofloxacin

Table 4. Antibiotic susceptibility of *S. aureus* and *L. monocytogenes*

Microbial Isolates	Source	Susceptibility (%)[1]	Antibiotics[2]																	
			Te	P	OX	C	S	GM	AN	NN	E	VA	B	F/M	AM	CF	SXT	CC	CIP	RA
S. aureus	Broiler carcasses	R	73.9	39.1	0	0	13.0	34.8	0	30.4	4.3	0	0	4.3	34.8	0	0	4.3	17.4	0
		I	0	0	0	0	0	26.1	0	13.0	0	0	0	0	0	0	0	0	0	0
		S	26.1	66.9	100	100	87.0	39.1	100	56.5	95.7	100	100	95.7	65.2	100	100	95.7	82.6	100
	Lettuce	R	10.5	84.2	0	0	0	15.8	0	5.3	52.6	0	0	0	84.2	0	0	0	5.3	0
		I	0	0	0	0	5.3	0	0	10.5	47.4	0	0	0	0	0	0	5.3	0	0
		S	89.5	15.8	100	100	94.7	84.2	100	84.2	0	100	100	100	15.8	100	100	94.7	94.7	100
	Hamburgers	R	33.3	100	0	0	0	0	0	0	33.3	0	0	0	100	0	0	0	0	0
		S	66.7	0	100	100	100	100	100	100	66.7	100	100	100	0	100	100	100	100	100
	Aquacultured flounders	R	33.3	100	0	0	0	0	0	33.3	0	0	0	0	100	0	0	0	0	0
		I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		S	66.7	0	100	100	100	100	100	66.7	100	100	100	100	0	100	100	100	100	100
L .monocytogenes	Broiler carcasses	R	42.9	0	NT[3]	0	0	0	0	0	0	3.7	0	32.1	0	0	0	10.7	0	0
		I	3.6	17.9	NT	0	0	0	0	0	0	0	0	35.7	0	0	0	45.4	21.4	0
		S	53.6	82.1	NT	100	100	100	100	100	100	96.3	100	32.1	100	100	100	42.9	78.6	100

[1]R; resistant I; intermediate S; sensitive
[2]Te; Tetracycline, P; Penicillin, OX; Oxacillin, C; Chloramphenicol, S; Streptomycin, GM; Gentamicin, AN; Amikacin, NN; Tobramycin, E; Erythromycin, VA; Vancomycin, B; Bacitracin, F/M; Nitro furantoin, AM ; Ampicillin, CF; Cephalothin, SXT; Trimethoprim/sulfamethoxazole, CC; Clindamycin, CIP; Ciprofloxacin, RA; Rifampin
[3] Broiler carcasses were not tested for oxacillin

Table 5. Percentage of multidrug resistant isolates from foods[1)]

Microorganisms	Broiler carcasses	Aquacultured flounders	Hamburgers	Lettuce
Salmonella spp.	61.1	ND[2)]	ND	ND
Coliforms	50.0	0	0	4.2
S. aureus	17.4	0	0	15.8
L. monocytogenes	0	ND	ND	ND
Vibrio spp.	-[3)]	71.4	-[3)]	-[3)]

[1)]Defined as resistance to more than four antibiotics
[2)]Organism was not detected in this food
[3)]These foods were not tested for *Vibrio* spp.

5). Multidrug resistant strains of *Salmonella* comprised 61.1% of the total isolates, and Te/S/AM/CB and Te/S/F/M/AM/CB were the most frequent multidrug resistance patterns. Half of coliforms from broiler carcasses showed multiple drug resistance. Te/AM/CB/CIP and Te/S/AM/CB/SXT/CIP were the most frequent multidrug resistance patterns of coliforms. *S. aureus* from broiler carcasses and lettuce also showed multidrug resistance at a rate of 17.4% and 15.8%, respectively. *Vibrio* spp. showed the highest multidrug resistance rate of 71.4% and S/AN/AM/CB/CF and AN/AM/CB/CF were the most frequent multidrug resistance patterns. In this study, over 90% of all isolates except *L. monocytogenes* were resistant to at least one antibiotic. Kang *et al.* (32) reported that about 70% of *Salmonella* isolates from broiler carcasses are resistant to more than 4 antibiotics, which is the highest resistance among strains ever reported in Korea. However, another study showed that 49% of *Salmonella* from chicken isolates are resistant to more than 4 antibiotics (33). The incidence of multidrug-resistant *Salmonella* spp. has increased worldwide. Reyna *et al.* (34) described a significant increase in the isolation of multiresistant strains from 0.6% in 1986 to 18.6% in 1991. Multiple resistances in England more than doubled from 5% in 1981 to 12% in 1988 (35). The incidence of multiple resistances (resistance to ampicillin, chloramphenicol, tetra-cycline, gentamicin and trimethoprim-sulfamethoxazole) increased from 10.6% in 1989-1992 to 19.7% in 1993-1996 (36).

In conclusion, broiler carcasses were contaminated with *Salmonella* spp., *S. aureus*, *L. monocytogenes* and coliforms. *S. aureus* and coliforms were isolated from all the foods tested. A high frequency of multidrug resistance was detected from broiler carcasses and aquacultured flounders. High levels of resistance to tetracycline, penicillin, ampicillin or carbenicillin were observed regardless of the isolates and foods. However, no data are available on the antibiotic use, feed source or hygiene for the food processing operation and distribution of these foods. There has been some research in Korea on the occurrence of antibiotic resistance in human pathogens, mostly from hospital patients, but little research has been conducted on bacteria isolated from foods. The level of antibiotic resistance found in our study suggests that more research is needed to better define the level of antibiotic resistance of foodborne bacteria in Korea.

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