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Antibiotic Resistance Among *Staphylococcus aureus* and *Escherichia coli* Isolated From Traditional and Industrial Food Samples

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Abstract

Background: Foodborne diseases are one of the serious problems in the world. Every year, more than 100 million people are affected by foodborne and waterborne diseases particularly immunocompromised diseases.

Objectives: The aim of the present study was to evaluate bacterial load and antibiotic resistance pattern in bacterial isolates from food samples of meat, dairy, and pastry products from west of Tehran, Iran, during April 2007 to March 2008.

Materials and Methods: A total of 1625 different food samples including dairy products, meat and pastries were collected randomly from different parts of the west of Tehran. All samples were kept at 4°C. The samples were first cultured according to the standard bacteriological methods and then *Staphylococcus aureus* and *Escherichia coli* isolates were identified using standard bacteriological tests. Antimicrobial susceptibility test was performed by disk diffusion method according to Clinical & Laboratory Standards Institute (CLSI) guidelines.

Results: During 2007 and 2008, 2.8% and 3% of the food samples were contaminated with *S. aureus*. Similarly, 3.5% and 6.4% of the food samples were contaminated with *E. coli*. *E. coli* isolates were highly resistant to amikacin and cephotaxime and this resistance was increased in 2008. Similarly *S. aureus* isolates were resistant to ciprofloxacin, cephotaxime, gentamicin, and tetracyclin. There was no significant difference during 2007-2008.

Conclusion: The rate of contamination during 2007 was 2.8% and during 2008 was 3% for *S. aureus*. This strain was isolated from the food samples.

Further studies should be done to determine the changes of bacterial resistance pattern for various food samples. Thus, the baseline for comparison with future prospective studies should be established, enabling the determination of trends over time.

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Introduction

Today, food spoilage is a part of worldwide problem, causing serious foodborne illnesses and resulting in a high burden on food producing companies.[1] Therefore, the microbiological safety of food is very important for the consumers, as well as food producing companies. The consumers need to purchase safe food products that do not involve any kind of risk for health.[2]

Thus, the acceptance and safety of a food product for the consumers depends in great part on the presence and nature of microorganisms. Common bacteria that cause food poisoning include *Staphylococcus aureus, Clostridium botulinum, Escherichia coli, Salmonella* and *Campylobacter* which can be isolated from food samples or environments.[3,4]

In recent years, antimicrobial resistance in bacteria have become a major public health problem all over the world.[5,6] Scanty information is available about the antimicrobial resistant bacteria in food samples in Iran.[3,7] According to a recent study from the Netherlands, more than 20% methicillin resistant *Staphylococcus* in human were originated from foods with animal origin.[8] Moreover, World Health Animals Organization has intended orders as antibiotic and antibiotic resistance assessment in livestock.[9]

This study aimed to evaluate bacterial load and antibiotic resistance pattern in bacterial isolates from food samples from west of Tehran and compare their

antibiotic resistance pattern during 2007 and 2008.

Materials and Methods

Sample Collection

According to the standard procedures, different food samples including dairy products, meat and pastries, were collected randomly from different parts of the west of Tehran and sent to Department of Microbiology, School of Medicine, Iran University of Medical Sciences during April 2007 to March 2008.

Isolation of *Escherichia coli* and *Staphylococcus aureus*

Isolation and identification of *E. coli* and *S. aureus* was performed according to the standard protocols of Isiri 2946, Isiri 9934, 6806-3.

Antimicrobial Susceptibility Tests

For all the target cultures, antibiotic susceptibility tests were performed according to disk diffusion method on Mueller-Hinton agar based on Clinical & Laboratory Standards Institute (CLSI) guidelines.[10] Antibiotic disks for all isolates of *E. coli* and *S. aureus* were as follows: cephotaxime (30 µg), amikacin (30 µg), tetracycline (30 µg), ciprofloxacin (5 µg), imipenem (10 µg), gentamicin (10 µg), and oxacillin (1 µg). *E. coli* 25922 ATCC and *S. aureus* 25923 ATCC were used as control.

Results

In the present study, 1625 samples (921 samples during 2007 and 704 samples during 2008) were collected and sent to Department of Microbiology, School of Medicine, Iran University of Medical Sciences. Table 1 shows absolute frequency distribution of samples examined according to product type and year. The highest rate of contamination during 2007 was 3.5% and during 2008 was 6.4%. *E. coli* was the most prevalent bacterium isolated from the food samples during 2008 (Table 2). Table 3 shows the rate of contamination during 2007 and 2008 which were 2.8% and 3%, respectively, for *S. aureus* isolated from the food samples.

In this study, the antibiotic resistance to various antibiotics are shown in Figures 1 and 2. The *E. coli* isolates were 8% and 38% resistant to amikacin during 2007 and 2008, respectively. There was no resistance to ciprofloxacin in 2007, however a resistance of 5% was seen in 2008. All the *E. coli* isolates were sensitive to imipenem. Similarly, *S. aureus* isolates were sensitive to imipenem during these 2 years, and the increase of resistance to ciprofloxacin, cephotaxime, gentamicin, and tetracycline, seen during the study, was not significant.

Discussion

Public health agencies are worried about food safety because of need to globalization of food markets all over the world. Concern for food safety is important because of possible contamination of these foods by foodborne pathogens. Furthermore, antibiotic resistance in bacteria isolated from food has been seen as a potential source of resistance in human pathogens.[11,12] Surveillance of the resistance rate among pathogens is clearly important in risk assessment and management.[13]

Table 1. Absolute Frequency Distribution of Samples Examined According to Product Type and Year

Year	Type of Product	Dairy	Meat	Confectionary	Total
2007	Traditional	55	170	73	298
	Industrial	459	125	39	623
	Total	514	295	112	921
2008	Traditional	99	99	12	210
	Industrial	404	77	13	494
	Total	503	176	25	704
Total	Traditional	154	269	85	508
	Industrial	863	202	52	1117
	Total	1017	471	137	1625

Table 2. Relative Frequency Distribution of *Escherichia coli* Culture-Positive Samples According to Product Type and Year

Year	Type of Product	Dairy (%)	Meat (%)	Confectionary (%)	Total (%)
2007	Traditional	9.1	3.5	0.0	3.7
	Industrial	4.1	0.8	2.6	3.4
	Total	4.7	2.4	0.9	3.5
2008	Traditional	22.2	2.0	8.3	11.9
	Industrial	4.0	3.9	7.7	4.0
	Total	7.0	2.8	8.0	6.4
Total	Traditional	17.5	3.0	1.2	7.1
	Industrial	4.1	2.0	3.8	3.7
	Total	6.1	2.5	2.2	4.7

Table 3. Relative Frequency Distribution of *Staphylococcus aureus* Culture-Positive Samples According to Product Type and Year

Year	Type of Product	Dairy (%)	Meat (%)	Confectionary (%)	Total (%)
2007	Traditional	16.4	1.8	12.3	7.0
	Industrial	0.4	0.0	7.7	0.8
	Total	2.1	1.0	10.7	2.8
2008	Traditional	7.1	0.0	50.0	6.2
	Industrial	1.2	1.3	15.4	1.6
	Total	2.4	0.6	32.0	3.0
Total	Traditional	10.4	1.1	17.6	6.7
	Industrial	0.8	0.5	9.6	1.2
	Total	2.3	0.8	14.6	2.9

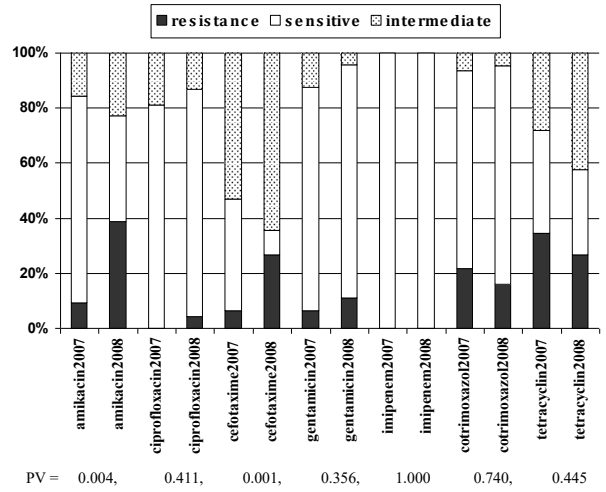

Figure 1. Relative Frequency Distribution of Antibiotic Sensitivity of *Escherichia coli* in Products According to Year.

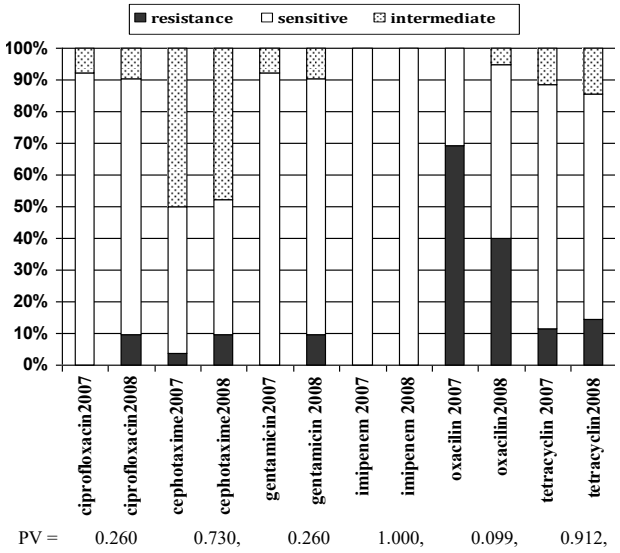

Figure 2. Relative Frequency Distribution of Antibiotic Sensitivity of *Staphylococcus aureus* in Products According to Year.

In this study, the presence of *E. coli* and *S. aureus* was found to be 4.7% and 2.9% during 2007 and 2008, respectively. The rate of *E. coli* contamination was 3.5% and 6.4% during 2007 and 2008, respectively. Similarly, rate of contamination with *S. aureus* was 2.8% and 3% during 2007 and 2008, respectively. The results showed that the contamination of traditional foodstuff is more than the contamination of industrial foodstuff. In contrast to our study, Gundogan et al reported 53% of food samples were contaminated with *S. aureus*.[14] Similarly, Atanassova et al found 51.1% of raw pork meat were contaminated with *S. aureus*.[15] Kalantar et al reported the highest rate of contamination was by *Klebsiella* spp. (40.9%), followed by *S. aureus* (31.8%), and *E. coli* (27.27%) from the traditional ice cream, cream pastries, and sausage in Iran.[3]

In this study, not only the rate of food contamination with *S aureus* and *E. coli* was studied, but also their microbial resistance pattern was emphasized. Antibiotic resistance to various antibiotics are shown in Figures 1 and 2. The *E. coli* isolates were resistant to amikacin in 2007 (8%) and to cephotaxime in 2008 (38%). There was no resistance to ciprofloxacin in 2007 but in 2008 resistance was 5%. The *S. aureus* isolates were sensitive to imipenem during 2007 and 2008 but resistance to ciprofloxacin, cephotaxime, gentamicin, and tetracycline increased in 2008 slightly. In contrast, resistance to oxacillin partially decreased in 2008. Both *E. coli* and *S. aureus* isolates were sensitive to imipenem. In the study of Heo et al, *S. aureus* isolates from meat origin showed the resistance rates of 92.9% and 50% to tetracycline and ampicillin, respectively.[16] Similarly, Otalu et al reported 100% resistance in *S. aureus* isolates from poultry meat against tetracycline and 61.5% against methicillin in Nigeria.[17] As a matter of fact, multidrug resistant *S. aureus* have been reported from several studies.[18,19]

Investigating the resistance pattern of *E. coli* isolates from traditional cheese in Greece showed that all of *E. coli* isolates were sensitive to ciprofloxacin, cotrimoxazole, and cephotaxime; but 50% of the same strains were resistant to tetracycline.[20] In comparison to other similar studies, our study could show the changes of microbial resistance pattern of *S. aureus* and *E. coli* in food during 2 consecutive years. Considering our results and other investigations', it may be concluded that use of antibiotics in treating the poultry infections or infections in the foods with animal source may increase the microbial resistance of these bacteria to antibiotics. However, further studies

should be done to determine the changes of bacterial resistance pattern. Thus, the baseline for comparison with future prospective studies should be established, enabling the determination of trends over time.

Authors' Contributions

MS: scientific consultant, TF: culture confirmation of the isolates and antibiotic resistance experiments, FA: help in editing, GRI: scientific consultant, MA: help in sample collection, MM: help in designing the experiments.

Ethical Approval

During the research multiple considerations have been supervised. Surveys have gone under examinations and ethical aspects have been highly approved.

Conflict of Interest Disclosures

The authors declare that they have no conflict of interests.

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