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Pathogenic Bacterial Contaminations in Hospital Cafeteria Foods

Paweena Rattanasena and Issaraporn Somboonwatthanakul
Department of Biotechnology, Faculty of Technology, Mahasarakham University Downtown Campus, Talad Sub-District, Maung District, Mahasarakham 44000, Thailand

Abstract: This study aims to examine the pathogenic bacterial contaminations in foods sold in hospital cafeteria. A study was conducted between April and September of 2008 using cafeteria located in Mahasarakham provincial hospital, Thailand, as a study area. The cafeteria foods were evaluated for contaminations with *Escherichia coli*, *Staphylococcus aureus*, *Salmonella typhimurium* and *Streptococcus faecalis*, which have been earlier reported to cause nosocomial outbreaks. Of 33 different types of ready-to-eat foods, the majority (54.54%) were found to have bacteria $>10^7$ colony forming units per gram of food (cfu g^{-1}), whereas 36.36% and only 9.10% of them were found to have bacteria at 10^6-10^7 and $<10^6$ cfu g^{-1}, respectively. In addition, most of ready-to-eat foods were also shown to be contaminated with *Escherichia coli* (57.57%), followed by *Streptococcus faecalis* (51.51%), *Staphylococcus aureus* (48.48%) and *Salmonella typhimurium* (27.27%), respectively. In contrast, of 7 different types of freshly-made foods, the majority (71.42%) were found to have bacterial $<10^6$ cfu g^{-1}. *Staphylococcus aureus* was the most commonly found bacteria in freshly-made foods (42.85%), followed by *Escherichia coli* and *Streptococcus faecalis* at equal percentages (14.28%). None of the freshly-made foods were found to be contaminated with *Streptococcus typhimurium*. The results concluded that a number of ready-to-eat foods sold in the Mahasarakham hospital cafeteria were contaminated with several pathogenic bacteria at unacceptable levels. Healthcare authorities should be more aware that ready-to-eat cafeteria foods that are heavily contaminated with pathogenic bacteria may be harmful to healthcare workers and visitors and may result in nosocomial infections of the patients.

Key words: Bacterial contamination, hospital cafeteria food, nosocomial infection, Thailand, patients

INTRODUCTION

The hospital areas and healthcare workers are required to be hygienic at all times, however, they can be contaminated with a number of pathogens which can subsequently infect the patients, particularly those with already severe underlying conditions. The infections that the patients acquired while receiving medical services as a complication of another disease are defined as nosocomial infections (nosocomial = hospital associated) (Ryan, 1994). Most common pathogens responsible for nosocomial infections are *Staphylococcus aureus*, *Enterococcus* sp., *Pseudomonas aeruginosa*, *Klebsiella* sp., *Escherichia coli*, *Acinetobacter* sp. and *Salmonella* sp. (Eckmanns *et al*., 2008; Luksamijarulkul *et al*., 2006; Macias and Ponce-de-Leon., 2005; Tantracheewathorn *et al*., 2007). Nosocomial infection outbreaks, especially caused by antibiotic-resistant pathogens, have resulted in severe economic loss and high rate of morbidity and mortality (Arabi *et al*., 2008; Cevik *et al*., 2005; Elward *et al*., 2005; Garcia-Martin *et al*., 2001; Groeneveld, 2009; Hassan *et al*., 2009; Laupland *et al*., 2006; Pancharti *et al*., 2005). There are several sources of nosocomial infections, including healthcare workers and visitors with poor hygiene compliance (Allegranzi and Pittet, 2009; Patarakul *et al*., 2005), infected hospital environment (Dancer *et al*., 2009), inadequately disinfected medical equipments (Kayabas *et al*., 2008), contaminated hospital food and water (Dhiraputra *et al*., 2005; Lund and Obrien, 2009; Wellinghausen *et al*., 2001) and contaminated items that have been brought to hospitals, for example, mobile phones (Brady *et al*., 2009). Recently, a number of reports also showed that contaminated food that were bought from outside to the hospitals (not being cooked by hospital nutritionists) could also transmit bacteria causing nosocomial infection outbreaks (O'Brien *et al*., 2001; Shetty *et al*., 2009; Winter *et al*., 2009).

Corresponding Author: Paweena Rattanasena, Department of Biotechnology, Faculty of Technology, Mahasarakham University Downtown Campus, Talad Sub-District, Maung District, Mahasarakham 44000, Thailand

In Thailand, a prevalence study of nosocomial infections in 2001 revealed that the nosocomial infection incidence rate was 6.4% and mortality rate of the patients with nosocomial infections was as high as 13.8%, of which 6.7% was directly due to nosocomial infections (Danchaivijitr *et al*., 2005b). More recently, a study in 2006 in 20 Thai hospitals showed that the prevalence rate of nosocomial infections was 6.5% with similar epidemiological pattern as in the report of 2001 (Danchaivijitr *et al*., 2007). The reason why the nosocomial infection incidence rates have not been decreased between 2001 and 2005 despite several attempts may be due to the lack of budget for surveillance and control, overworking healthcare workers and poor healthcare workers' and visitors' compliance (Buachum *et al*., 2005; Danchaivijitr *et al*., 2005a, 2007; Patarakul *et al*., 2005). Particularly, overcrowded hospitals often result in negligence of healthcare workers to examine the sanitary of items or foods brought to hospital areas. Therefore, due to several unique characteristics of Thai hospital settings, the causes of nosocomial infections can be different from hospitals in other countries and the surveillance based on real circumstances in Thailand would thus be of extreme value. This study aims to investigate the bacterial contaminations in foods sold in hospital cafeteria as these foods are likely to be consumed by healthcare workers, visitors or even the patients and may lead to infections of these people. This may eventually cause widespread outbreak of nosocomial infections. The study focuses on contaminations with *Escherichia coli*, *Staphylococcus aureus*, *Streptococcus faecalis* (previously known as *Enterococcus faecalis*) and *Salmonella typhimurium* since contaminations with these types of bacteria have been associated with poor handling/manipulation of food and earlier reported to cause nosocomial infection outbreaks. This study also emphasizes on the comparison between ready-to-eat foods (referred to the foods that have been cooked in advance and can be eaten when purchased) and freshly made foods (referred to the foods that have been cooked only when ordered) for their prevalence of bacterial contaminations.

MATERIALS AND METHODS

Study area: The study was undertaken using cafeteria located in Mahasarakham hospital between April and September of 2008. Mahasarakham hospital is a major public hospital located in the centre of Mahasarakham province, Thailand. From statistic data in 2008, Mahasarakham hospital has 1,157 admissions/day, 472 beds, 62 doctors, 390 nurses and 1,094 general staff members.

Aerobic plate count: Forty different types of foods (33 ready-to-eat foods and 7 freshly-made foods) were purchased from hospital cafeteria and immediately examined for bacterial contaminations. The foods were processed according to the guideline of Bacteriological Analytical Manual (BAM) of US Food and Drug Administration (FDA). Fifty grams of each food were mixed with 450 mL of nutrient broth (resulting in a dilution of 10^{-1}) and blended until it became homogenate. The original homogenate was further diluted to be 10^{-3}, 10^{-4}, 10^{-5} and 10^{-6} using nutrient broth and 0.1 mL of diluted homogenate was spread on nutrient agar. The plates were incubated at 35° for 24-48 h. The total aerobic colonies were counted and calculated as colony forming units per gram of food (cfu g^{-1}). Each food sample was tested in triplicate.

Bacterial identification: Four selective media were used for presumptive identification of pathogenic bacteria: Bismuth Sulfite Agar for *Salmonella typhimurium,* MacConkey Agar with Sorbital for *Escherichia coli*, Mannitol Salt Agar for *Staphylococcus aureus* and Bile Esculin Azide Agar for *Streptococcus faecalis* (all media were purchased from Criterion, Hardy diagnostics, CA, USA). The cafeteria foods were processed as for aerobic plate count and each diluted food homogenate (0.1 mL) was spread on the four different selective media agar plates. The positive colonies grown on selective media agar were subcultured on nutrient agar and used for further identification by gram staining and appropriate biochemical tests according to the guideline of BAM (FDA). Each food sample was tested in triplicate. The commercial ATCC strains of bacteria (*Salmonella typhimurium* ATCC® 14028, *Escherichia coli* ATCC® 25922, *Staphylococcus aureus* ATCC® 25923, *Streptococcus faecalis* ATCC® 29212) were used as positive controls throughout the experiment.

RESULTS

The data from total aerobic plate count (Table 1) showed that, of 33 different ready-to-eat foods, the majority (54.54%) were found to be contaminated with bacteria $>10^7$ cfu g^{-1}, whereas 36.36% of them had bacteria around 10^6-10^7 cfu g^{-1}. Only 9.10% of ready-to-eat foods were contaminated with bacteria $<10^6$ cfu g^{-1}. In contrast, of 7 different freshly-made foods, the majority (71.42%) were found to have bacteria $<10^6$ cfu g^{-1} (Table 1).

Table 1: Percentages of foods with different levels of aerobic bacterial plate count (cfu g^{-1})

		Percentage of foods		
Type of foods	Total No. of foods	$<10^6$ cfu g^{-1}	10^6 to10^7 cfu g^{-1}	$>10^7$cfu g^{-1}
Ready-to-eat	33	9.10	36.36	54.54
Freshly-made	7	71.42	14.29	14.29

Ready-to-eat foods are referred to the foods that have been cooked in advance and can be eaten when purchased; Freshly made foods are referred to the foods that have been cooked only when ordered

Table 2: Percentages of foods contaminated with identified strains of bacteria

		Escherichia coli		*Staphylococcus aureus*		*Salmonella typhimurium*		*Streptococcus faecalis*	
Type of foods	Total No. of foods	No.	%	No.	%	No.	%	No.	%
Ready-to-eat	33	19	57.57	16	48.48	9	27.27	17	51.51
Freshly-made	7	1	14.28	3	42.85	0		1	14.28

Ready-to-eat foods are referred to the foods that have been cooked in advance and can be eaten when purchased; Freshly made foods are referred to the foods that have been cooked only when ordered

In addition, most of ready-to-eat foods (57.57%) were found to be contaminated with *Escherichia coli*, followed by *Streptococcus faecalis* (51.51%), *Staphylococcus aureus* (48.48%) and *Salmonella typhimurium* (27.27%), respectively (Table 2). Up to 42.85% of freshly-made foods were found to be contaminated with *Staphylococcus aureus*, followed by *Escherichia coli* and *Streptococcus faecalis* at equal percentage (14.28%) (Table 2). None of freshly-made foods were found to be contaminated with *Salmonella typhimurium*.

DISCUSSION

There are several investigations for food- borne nosocomial outbreaks that only focused on foods served in hospitals (Dhiraputra *et al*., 2005; Graham *et al*., 2002; Lund and O'Brien, 2009; O'Brien *et al*., 2001; Shetty *et al*., 2009; Winter *et al*., 2009) but the foods brought from outside hospitals have not been widely regarded as a cause of food- borne nosocomial infections. However, the foods from outside hospitals that usually remain unchecked by healthcare workers have often been served to vulnerable patients. Therefore, they are likely to be a link to food-borne nosocomial infections as well. The results from examination of foods sold in Mahasarakham hospital cafeteria, Thailand, showed that pathogenic bacterial contaminations were much higher in the ready-to-eat foods than in those that were freshly-made (Table 1). The ready-to-eat cafeteria foods were also found to be contaminated with *Escherichia coli*, *Staphylococcus aureus* and *Streptococcus faecalis* at similar rates (Table 2). Up to half of the ready-to-eat foods were contaminated with two or more strains of these pathogenic bacteria (data not shown). The pathogenic bacteria contaminated in hospital cafeteria foods could be transmitted to patients via several routes. Firstly, the visitors who may bring contaminated food from the hospital cafeteria to the patients for consuming. It is a general custom in Thailand that the visitors often bring food as a gift for better wellbeing or as a patient's request and bringing foodstuffs from outside hospitals to patients is generally not forbidden. Also, Thai healthcare workers, especially nurses in public hospitals, are often required to overwork due to shortages of staff and they do not generally have time to examine the foodstuffs the visitors bring to patients. If such food is heavily contaminated with bacteria, the patient who consumes it or is in contact with it could possibly be infected and perhaps cause nosocomial infection outbreak. Although, there was no record in Thailand regarding the prevalence of nosocomial outbreak because of the food brought from outside hospital and such prevalence can be difficult to determine due to the lack of effective surveillance system, the data elsewhere have shown that there are several outbreaks within hospitals due to the foods brought from outside hospitals, for example, the home-prepared Chinese meal that caused outbreaks of *Salmonella* enteritidis gastrointestinal infections among medical staff (Metz *et al*., 2001) the ready-to-eat sandwiches and scalded sausages that caused *Listeria monocytogenes* infections among patients (Graham *et al*., 2002; Shetty *et al*., 2009; Winter *et al*., 2009) and the home-baked cream-filled cakes that caused *Escherichia coli* O157 outbreak among both medical staff and patients (O'Brien *et al*., 2001). The outbreak of *Salmonella* sp. that directly associated with hospital cafeteria has also been reported (Johnson *et al*., 2001). Secondly, since, poor hand-hygiene compliance have been observed among Thai healthcare workers and visitors (Patarakul *et al*., 2005) if the visitors or healthcare workers consumed contaminated food at the hospital cafeteria, their hands, clothes, or other items may be contaminated with pathogenic bacteria and they could transmit these bacteria to patients, perhaps resulting in nosocomial infections. There were several reports showing that the contaminated items might transmit the pathogenic strains

of nosocomial bacteria, for instance, coins (Tolba *et al*., 2007) clothes, wristwatches, wedding rings, neck ties (Dancer, 2010) and mobile communication devices (Brady *et al*., 2009). These contaminated items might serve as vehicle for pathogenic bacteria and thus lead to staff-to-patient or patient-to-patient transmission. Nonetheless, there is still no conclusive evidence to suggest the relationship between the contaminated items and the spread of pathogens in hospital environment. Lastly, if the visitors and healthcare workers are infected due to contaminated cafeteria food, they may unintentionally be carriers or reservoirs of pathogens. The asymptomatic healthcare workers have been reported to be responsible for prolonged outbreaks of nosocomial infections (Ben-David *et al*., 2008; De Vries *et al*., 2006; Occelli *et al*., 2007). As this study suggested that as much as 43% of freshly-made cafeteria foods were free of *Escherichia coli*, *Staphylococcus aureus*, *Streptococcus faecalis* and *Salmonella typhimurium* contaminations (data not shown), health authority should thus educate and encourage hospital cafeteria staff to provide more choices of freshly-made foods and to reduce cooking ready-to-eat foods. This may help reducing the risk of nosocomial infection outbreaks.

CONCLUSION

This study showed the high levels of pathogenic bacterial contaminations in foods available in Mahasarakham hospital cafeteria. The routine check of sanitary of foods sold in hospital cafeteria could help to reduce the possibility of patients being exposed to pathogenic bacteria and therefore the incidence of nosocomial infections.

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