Microbiological quality and handling practices of ice served in selected downtown Toronto food premises

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Abstract: Consumable ice presents a potential hazard due to microbiological contamination. To investigate the microbiological quality and handling practices of ice served in selected food premises in downtown Toronto, Ontario, 64 ice samples were collected from 40 food establishments. The ice samples were tested for the presence/absence of total coliforms and *Escherichia coli*. Five samples (7.8%) tested positive for total coliforms, all of which were sampled from the customer service areas. None of the ice samples tested positive for *E. coli*. A visual inspection was carried out to determine general ice handling practices in the food premises sampled. Of the 40 premises sampled, 14 (35%) had dirty ice holding/storage equipment, 13 (32.5%) had inappropriately stored scoops, and 6 (15%) had visible biofilm on the ice machines. In 15 (37.5%) premises, the ice was uncovered when not in use and 4 (10%) premises had food safety violations relating to the inability to protect food from contamination. The presence of total coliforms and the lack of proper ice handling practices among several food premises suggest that consumable ice served in downtown Toronto food premises may present a potential hazard.

Key words: Ice, bacteria, public health, consumer safety

Background

According to the *Ontario Health Protection and Promotion Act* (HPPA, 1990a) ice is considered food. Food premises use consumable ice as a component in a variety of cold drinks. Ice is perceived as a food that is safe to eat owing to its frozen nature (Nova Scotia Environment and Labour, 2005). However, studies have confirmed the presence of harmful pathogens in ice cubes used to prepare beverages. Pathogens that have been dectected in ice include *Escherichia coli, Pseudomonas aeruginosa*, *Clostridium perfringens* spores, *C. perfringens, P. aeruginosa, Salmonella* spp., *Shigella* spp., *Campylobacter* spp, *Vibrio cholera, Aeromonas* spp. and *Yersinia* spp. (Gerokomou et al., 2011; Wilson et al., 1997). Generally, ice used in consumer beverages are either made in the food premises or bought from ice manufacturers. Regardless of the source, ice may be contaminated with microorganisms at the point of manufacture or the point of use. The poor microbiological quality of ice may be due to contaminated ice holding and service equipment; poor food handler's hygiene; unsanitary ice-handling procedures during production, packaging, transportation, and storage; and contaminated water used in ice production (Wilson et al., 1997).

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The Ontario *Food Safety Protocol* requires Boards of Health to conduct surveillance and inspection of food premises to identify hazards to the public in such settings, to respond to foodborne illness (FBI) outbreaks promptly, and to perform food safety awareness. The ability of microorganisms to survive and grow in ice makes consumable ice a potentially hazardous food. The *Backgrounder for Food Safety and Foodborne Illness* in Toronto (2013) cites that one in every six residents of Toronto experience FBI every year, and each case can represent 227 unreported cases (Toronto Public Health, 2013). Although the common foods associated with FBI are generally raw foods from animal origin and produce (Centre for Disease Control, 2013; Toronto Public Health, 2013), it should be noted that the cause of most FBI remains unresolved due to an unknown source. Ice is a hazardous food capable of causing FBI as illustrated by the study findings of Gerokomou et al. (2011) and Wilson et al. (2007).

The objectives of this study include examining consumable ice quality and handling practices within food premises in downtown Toronto, Ontario. Further, this study supports the surveillance and inspection of food premises by identifying possible public health hazards from ice consumption, ice handling practices that potentially contribute to ice contamination in food facilities, and practices that increase the risk of FBI to those consuming such ice. It will also introduce new perspectives to routine food establishment inspection procedures by revealing the unsafe ice handling practices that can be incorporated into the regular food premise inspections and

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food handlers training sessions. In the same way, it points to need for considering ice as a source when investigating FBIs.

Methods

Sampling procedure

Forty food premises scheduled for food safety inspections in March 2014 were selected for sampling using simple random sampling. To be eligible for sampling, the food premise had to serve consumable ice to the public. Nonedible ice was not considered in this study. The sampling area and map were provided by Toronto Public Health's Healthy Environments, South Division. Sixty-four ice samples were collected from the selected food premises' ice machines and (or) ice storage/holding equipment in service areas or back areas (or both, if available) using a sterile sampling bag. Each sample weighed at least 100 g. All samples were collected while accompanied by a certified Public Health Inspector (PHI) responsible for the area in which each selected food premise was located. Service areas were defined to include ice machines or any ice holding equipment located in the area where ice was scooped and directly added to a customer's drink or where is was directly consumed. Back areas included ice machines that were located away from where ice was served to customers but that were used to provide ice to the service area. A sample was taken from both the service and back areas of the food premises if it had consumable ice in both areas so that they could be compared. The ice samples were thawed and sodium thiosulphate was added to neutralize any chlorine present before being transported to the laboratory for analysis.

Microbiological analysis

Total coliform (TC) and *E. coli* counts were determined using membrane filtration with a 100 mL sample size. Laboratory analysis for indicator organisms was performed using the Ontario Ministry of Environment's guideline MICROMFDC-E3407, version 4 (Ministry of Environment, 2012). A vacuum was used to draw 100 mL of the water through a 47 mm diameter, 0.45 m pore size cellulose ester membrane filter. After filtration, the filters were placed onto differential coliform agar plates that were then incubated at 36.0 $\pm$ 1.0 °C for 24 $\pm$ 2 hours. After incubation, the number of total coliforms and *E. coli* were counted and reported as colony forming units (CFU) per 100 mL of the ice sample. Red/pink colonies were confirmed as coliforms and purple/blue colonies were confirmed as *E. coli* (Ministry of Environment, 2013).

Visual inspection

A visual inspection of ice service areas, equipment, and sanitary practices was conducted alongside ice sampling. The results of the inspection were recorded on a specifically designed survey form. The criteria used in the visual inspection included the cleanliness and sanitary condition of the ice machine where ice was sampled, cleanliness of the ice service equipment, and previous food safety violations relating to improper food handling or failure to protect consumable ice from contamination. The ice machine or ice holding equipment in the service areas and back areas were considered unclean if any or all of the following conditions were observed at the time of inspection: visible slime, visible biofilms, or visible signs of dirt inside the ice storage equipment or any part of the machine/ice service equipment that comes into contact with water used to make ice or the ice itself. The ice collection method was assessed based on what the food premise regularly used to serve ice to the customer or to scoop ice for the refill of service area ice holding equipment. However, employee ice handling practices were only observed if the employee was handling ice at the time of inspection. Food safety violation information was identified from inspection reports posted on the Toronto Public Health DineSafe website (Toronto Public Health, 2013).

Results

Microbiological analysis

Sixty-four samples were taken from the 40 food premises sampled. No samples tested positive for *E. coli*. Five samples (7.8%) tested positive for total coliforms. All five positive samples were collected from the service areas, indicating that 16% of the ice samples ($n = 31$) collected specifically from service areas were contaminated. Total coliforms in the positive samples ranged from 4 to >80 CFU/100 mL. Two samples had a count of 4 CFU/100 mL, one with a count of 75 CFU/100 mL and two with counts >80 CFU/100 mL (Table 1).

Visual inspection

Of the 40 premises sampled, 22.5% ($n = 9$) had dirty ice holding/storage equipment, with the presence of physical dirt and (or) biofilm on the ice machines and bins. Four ice samples were visibly contaminated with food particles and two food premises stored other items in the consumable ice; one had bottles and another had glasses on the ice.

Another issue was the inappropriate storage of the scoop between services. Of the 40 premises inspected, 32.5% ($n = 13$) inappropriately stored their scoops between services. Some of the unsafe ice handling practices identified included storing the scoop with other equipment that could contaminate it (such as cleaning gloves), on top of the recycling bin, inside a bucket used for making sauce, inside ice machines or ice holding equipment, inside the hand-washing sink, and the

Table 1. Summary of the results of laboratory analysis on the prevalence of indicator organisms in the ice samples

Sampling area	No. of samples	No. of positive samples		Range (CFU/100 mL)
		TC	*E. coli*	
Back areas	32	0	0	—
Service areas	32	5	0	4 to >80

scoop being placed on top of the service counter or held on the serving end when being handed to the researcher during sampling.

Six premises (15%) had visible biofilm on their ice machines, whereas 37.5% ($n = 15$) did not cover the ice when it was not in use. The majority of the premises were in compliance with food safety requirements, although four of the 40 premises inspected had previous compliance violations. These compliance violations related to their inability to protect food from contamination. However, none of the samples collected from these food premises tested positive for TC.

Of the five premises with positive TC ice samples, 80% ($n = 4$) either improperly stored the scoop for handling ice or the scoop was visibly dirty ($n = 2$); one had dirty ice storage equipment in the service area and none of the ice in these food premises were covered to protect them from contamination. However, the premises had no previous food safety violations and the ice served did not show any physical adulteration (Table 2).

Table 2. Summary of the visual inspection results and the ice handling practices observed during the visual inspection including the results of the premises with positive TC laboratory results

Issue	All premises	Premises with positive TC
Cleanliness of ice storage equipment		
Clean	25	4
Dirty	9	1
Biofilm on machines	6	0
Cleanliness of ice		
Clean	36	5
Dirty	4	0
Storage of scoop between service		
Appropriate	27	1
Inappropriate	13	4
Cleanliness of scoop		
Clean	35	2
Dirty	5	3
Ice machine/storage equipment*		
Lid closed/enclosed	49	0
Open/unenclosed	15	5
Stores items other than ice	2	0
Food safety compliance		
Violated	4	0
Complied	36	5

**Based on the total number of ice machines/storage equipment sampled (64) and not the number of premises.*

Discussion

According to the *Ontario Safe Drinking Water Act, Regulation 169/03* (Government of Ontario, 2002), TC and *E. coli* should not be detectable in potable water. The TC detected in the ice samples in this study represented 12.5% of the total premises sampled ($n = 40$) and 16.1% of ice sampled from service areas ($n = 31$). In comparison, Gerokomou et al. (2011) investigated the hygienic status of commercial ice used to cool drinks and food in Greece and found coliforms and *E. coli* in 31% and 22% of samples, respectively; they also isolated *Yersinia* spp., *P. aeruginosa*, and *C. perfringens* spores. Schmidt and Rodrick (1999) surveyed packaged ice in Florida, U.S.A, and found that coliform counts exceeded the state regulatory limit of <1 CFU/100 mL in 13.5% of ice produced in manual, on-premises facilities compared with 3.6% of samples produced in mechanical, off-premises facilities. Nichols et al. (2000) took 3,528 samples of ice used to cool drinks from retail and commercial premises and found that 9% of these samples contained coliforms and 1% were positive for *E. coli*. White et al. (2010) sampled drinks and ice from soda machines in the United States and reported that of the nine ice samples taken, eight showed microbial contamination; however, none of the samples had a plate count greater than 500 CFU/mL or contained coliform bacteria. Wilson et al. (1997) conducted a study to determine the bacterial quality of ice in hospitals, public bars, hotels, and restaurants in the United Kingdom. This study detected a low number of *E. coli* in community samples, but found that hospital samples yielded various opportunistic microorganisms including *Staphylococcus* and *Bacillus*, both of which are known to cause various infections in patients with compromised immunity.

Food premises sampled in the study utilized treated municipal water for ice production, and the microbiological standards from Regulation 169/03 also apply to municipal water systems (Government of Ontario, 2002). As shown in Table 1, only the ice sampled from the service areas had positive TC counts ($n = 5$) and it was concluded that the presence of TC in the ice samples was likely due to poor ice handling practices post-production and not as a result of poor municipal water quality. As shown in Table 2, the visual inspection of the 40 food premises identified a number of unsafe ice handling practices. Although the unsanitary practices varied among premises, poor ice handling practices were observed in all of the five premises that recorded positive TC counts (Table 2). These poor ice handling practices may have contributed to the contamination of the ice samples that tested positive for TC. The presence of visible dirt on the ice and inappropriate use and storage of ice scoops provide opportunities for cross-contamination. The use of glasses and cups as ice scoops could increase the likelihood of ice contamination because a greater area of the glass and cups come into contact with the food handler's hand.

The presence of biofilm was noted in six premises (Table 2). Biofilm is a combination of slime, fungus, mould, and other microorganisms (Powitz, 2013). The presence of biofilm indicated a lack of regular cleaning and sanitization or maintenance of an ice machine or ice holding equipment. The occurrence of a biofilm in equipment used to hold consumable products presents a public health hazard (Donlan, 2001).

Legionella pneumophila (Schuetz et al., 2009) and *Mycobacterium fortuitum* (Gebo et al., 2002) isolated from ice machines have been linked to outbreaks in healthcare settings. Furthermore, biofilm-associated microorganisms have been associated with antimicrobial resistance (Donlan, 2001). Burnett et al. (1994) suggested that the lack of cleaning of ice machines plays a role in ice contamination. Wilson et al. (1997) attributed ice contamination to ice handling equipment such as the ice machines, tongs, ice storage/holding equipment, and contamination from food handler's hands and clothing. Nichols et al. (2000) concluded that the microbiological quality of ice depends on the type of premise, place of ice production, and the uses for ice. Norfolk District Council Environmental Health Department (2013) cited poor personal hygiene, unsanitary storage/service equipment, and a lack of maintenance or poor cleaning of ice machines as the primary sources of ice contamination.

The Ontario HPPA (1990b) requires that any food for human consumption be handled in a sanitary manner (Section 17, Regulation 562 (Food Premises) and Section 26) and discourages bare-hand food handling and supports the use of "tongs, spoons and scoops of corrosion-resistant and nontoxic material" (Section 24, Regulation 562). New York State has specifically implemented targeted interventions for handling ice. *Sanitary Code for Food Service Establishments* outlines requirements specific to handling ice for consumption other than the general safe food handling requirements (Government of New York, 1997). Although Subparts 14-1.80 and 87(d) have similar requirements to Ontario's Regulation 562 (Sections 26 and 24), Subparts 14-1.80(a) and 14-1.87(d) unequivocally require food handlers to avoid bare-hand contact of food and ice, respectively. Indeed, the legislation provides specific ice handling requirements concerning ice storage (Subpart 14-1.43(d)), service and handling of ice (Subpart 14-1.87(d)), and the location of "ice makers and ice storage equipment" (Subpart 14-1.100) that go beyond general safe food handling. Provisions of such requirements in Regulation 562 and (or) municipal by-laws would be relevant to surveillance of food premises and to enhance the safety of consumable ice. Incorporating sanitary ice handling requirements explicitly into food safety policies would equip PHIs with a provision for enforcing the minimum standard expected from food handlers handling ice.

It was concluded that the detection of TC in ice served in downtown Toronto did not present an immediate public health hazard. The majority of ice sampled was microbiologically safe, and the ice handling and serving practices were largely appropriate. However, the presence of contaminants in consumable ice manufactured using potable water, in addition to the observation of unsanitary ice handling practices, shows that there is a potential for pathogens to contaminate the ice. Because the visual inspection identified several unsanitary ice handling practices, the study recommends that the ice handling practices should be targeted during food safety inspections and awareness/training.

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