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The microbiological quality of take-away raw salmon finger sushi sold in Hong Kong

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ABSTRACT

The safety of ready-to-eat foods is an important issue. Improper storage and handling of ready-to-eat items may lead to foodborne disease outbreaks. In this study, raw salmon finger sushi (nigiri) was selected as a target ready-to-eat food for microbiological surveillance. The aim of this study was to evaluate the microbiological quality of take-away sushi sold in the licensed sushi shops in Hong Kong. Sushi samples were collected from 120 randomly selected licensed sushi shops in the 19 districts in Hong Kong from 1st June to 30th July 2014. They were tested for aerobic colony count (ACC), *Escherichia coli* and *Staphylococcus aureus* counts as well as the presence of *Salmonella* spp. to evaluate their overall hygienic quality. None of the samples was found to contain *Salmonella* spp. and 1.7% of the collected samples were classified as unsatisfactory for containing more than 100 CFU/g of *E. coli* indicating the overall hygienic quality of take-away sushi in Hong Kong was good. There was no significant difference between samples purchased from chain stores and those from self-hosted business, suggesting that microbiological quality of take-away sushi was not affected by these two types of business models. Based on the current findings, it was suggested that the government should have more frequent routine inspections and provide food hygiene education to the workers in the sushi shops in Hong Kong so as to minimize the risk of food-borne disease outbreaks.

1. Introduction

Ready-to-eat food refers to food for direct human consumption without further cooking or processing to eliminate or reduce microorganisms of concern to an acceptable level (CFS, 2014). Sushi and sashimi are traditional Japanese ready-to-eat foods. Sushi mostly consists of cold cooked vinegared rice that is shaped into bite-size pieces and topped with raw or cooked fish, or formed into a roll with fish, vegetables or egg and often wrapped in seaweed; while sashimi is thinly sliced raw meat, such as squid, tuna or salmon. Between sushi and sashimi, sushi is tasty but not expansive. It is considered as a nutritious food and gains increasing popularity around the world. Recently, the number of sushi shops in Hong Kong has been increasing throughout the past few years.

According to a food surveillance programme carried out by Hong Kong Food and Environmental Department (FEHD), 3% of the reported food poisoning outbreaks in Hong Kong from 1997 to 1999 were found to be associated with *Vibrio parahaemolyticus, Bacillus cereus, Staphylococcus aureus, Salmonella* spp. and *Listeria Monocytogenes* in sushi and sashimi (FEHD, 2000). In other countries, outbreaks related to sushi specialties have also been reported, for example, an outbreak of enterotoxigenic *Escherichia coli* infection in Reno, Nevada, in 2004 (Jain et al., 2008) and a 20-state outbreak of *Salmonella* in USA (Lester, 2012).

Several factors have contributed to the high reported outbreaks related to sushi. First of all, some ingredients in sushi are similar to raw meats from animals. Consumption of them incurs potential health risks such as ingestion of pathogenic bacteria or parasites

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(Altekruse, Cohen, & Swerdlow, 1997; Nawa, Hatz, & Blum, 2005). Secondly, ingredients of sushi are always prepared in advance for quick serve and sushi is directly contacted with handlers' hands and cutting board during its preparation. These factors lead to an increased incidence of contamination with potential foodborne pathogens, such as *Staphylococcus* (Christison, Lindsay, & von Holy, 2008). Lastly, similar to other ready-to-eat foods, sushi is consumed with no further treatment to reduce microbiological content. Therefore, sushi is normally regarded as a potentially hazardous food (NSW Food Authority, 2008) and monitoring the microbiological quality of it is important for preventing the outbreaks of food poisoning.

In the current study, the hygiene level of licensed sushi shops in Hong Kong was assessed by monitoring the microbiological quality of their ready-to-eat foods. Among different types of food, raw salmon finger sushi (nigiri) was chosen as a representative ready-to-eat food in sushi shops. The aim of this study was to evaluate the microbiological quality of take-away sushi sold in licensed sushi shops in the 19 districts in Hong Kong, in order to evaluate the hygiene level of sushi shops and give some recommendations to improve food safety. Hygiene indicator organism *E. coli* and specific foodborne pathogens *S. aureus* and *Salmonella* spp. in sampled sushi were examined.

2. Materials and methods

2.1. Sampling

Information on all the licensed shops approved to sell sushi for consumption was obtained from the Food and Environmental Hygiene Department of Hong Kong. The licensed sushi shops were first divided into 19 groups according to their location in the 19 official administrative districts in Hong Kong: “Yau Tsim”, “Wong Tai Sin”, “Central & Western”, “Sham Shui Po”, “Sha Tin”, “Tai Po”, “Eastern”, “Yuen Long”, “Southern”, “Kwai Tsing”, “Kowloon City”, “Wan Chai”, “North”, “ Tuen Mun”, “Mong Kok”, “Tsuen Wan”, “Sai Kung”, “Kwun Tong” and “Islands”. Licensed sushi shops which had no take-away service, including hotels, wine shops and premises offering buffet, were excluded from the sampling list. They were then subdivided into two groups according to the types of shops, namely “chain stores” and “self-hosted business”. After that, 10% of the remaining licensed sushi shops were randomly sampled from each district. Raw salmon finger sushi (nigiri) samples were collected directly from the take-away service in a total of 120 sushi shops in Hong Kong from 1st June to 30th July 2014. Sample collection time was between 12:00 noon and 2:00 pm. At least 50 g of sample was purchased from each sushi shop and kept in its original packing. Then the sample was put into an individual sterile Whirl-Pak bag (Whirl-Pak®, Nasco, USA) and placed into insulation box with ice packs for transportation to the laboratory. The samples were transported from the purchase place to the laboratory within 2 h, and immediately transferred to a refrigerator (4 °C) until analysis. The analysis was carried out on the same date of sampling.

2.2. Evaluation of microbial counts

2.2.1. Preparation of materials

For tests of aerobic colony counts (ACCs), *E. coli* count, and *S. aureus* count, phosphate buffered saline (PBS) was used for dilution. PBS was prepared (per liter) by dissolving 34 g KH_2PO_4 (Sigma–Aldrich®, Germany) in MilliQ water (Millipore, Bedford, MA, USA) and bringing the volume to 1 L with MilliQ water after adjusting pH to 7.3 with NaOH (1 N) (Sigma–Aldrich®, Germany). Then 1.25 ml of the above stock solution was taken and further diluted to 1 L with MilliQ water.

For testing of *Salmonella* spp., buffered peptone water (BPW) was used for *Salmonella* spp. non-selective pre-enrichment. BPW was prepared (per liter) according to the manufacturer's instruction by dispersing 20 g buffered peptone medium (Lab M, United Kingdom) in MilliQ water. Iodine solution was prepared by dissolving 6 g of iodine crystals (ACCUCHEM) and 5 g of potassium iodide (ACCUCHEM) in 20 ml MilliQ water.

Tetrathionate (TT) broth and Rappaport Vassiliadis Soya (RVS) broth were used for *Salmonella* spp. selective enrichment. TT broth was prepared (per liter) by dispersing 46 g TT medium (Lab M, United Kingdom) in MilliQ water, while RVS broth was prepared (per liter) by dispersing 26.6 g RVS medium (Lab M, United Kingdom) in MilliQ water. Xylose Lysine Deoxycholate (XLD) agar (Lab M, United Kingdom) and Brilliant Green (BG) agar (Lab M, United Kingdom) were used for the isolation of *Salmonella* spp. These two types of commercial agars, XLD and BG, were prepared according to their manufacturer's instructions.

2.2.2. Sample preparation

Before collecting the sample, all the related benches and equipment were disinfected. Each sample (25 g) was cut into small pieces with sterile scissors and aseptically transferred to Seward Stomacher® Bags. Then 225 ml of PBS and BPW were added respectively, and homogenized in a Seward Stomacher® 400 circulator at 200 rpm for 60 s. Each sample was tested in triplicate. The used samples were stored below 4 °C.

2.2.3. Enumeration of ACCs, E. coli counts and S. aureus counts

3 M™ Petrifilm™ Aerobic Count Plate, *E. coli*/Coliforms Count Plates, and Staph Express Count Plates were used for enumeration of ACCs, *E. coli* counts, and *S. aureus* counts of the samples, respectively. For ACCs enumeration, 100-fold (1:99 w/v ratio), 1000-fold (1:999 w/v ratio) and 10,000-fold (1:9999 w/v ratio) dilutions of the homogenate were prepared using PBS; for *E. coli* counts and *S. aureus* counts enumeration, 10-fold (1:9 w/v ratio) and 100-fold (1:99 w/v ratio) dilutions were prepared using PBS. According to the manufacturer's instructions, 1 ml of samples dilution was inoculated into each plate and then incubated in an incubator at 35 ± 1 °C. The incubation time for *E. coli*/Coliforms Count Plates and Staph Express Count Plates was 24 ± 2 h, and that for ACCs was 48 ± 3 h.

The results of ACCs were interpreted by counting the number of red colonies on Aerobic Count Plates according to manufacturer's instructions. On *E. coli*/Coliforms Count Plates, the number of red colonies associated with entrapped gas was interpreted as coliforms count, while that of red-blue colonies associated with entrapped gas was interpreted as *E. coli* count. The number of red-violet colonies on Staph Express Count Plates was interpreted as *S. aureus* count.

2.2.4. Isolation of Salmonella spp.

For the isolation of *Salmonella* spp., homogenate of 25 g samples with BPW was incubated in an incubator at 37 ± 1 °C for 24 h. Then, 0.1 ml of this non-selective pre-enrichment culture was inoculated to 10 ml of RVS broth and 1 ml of this pre-enrichment culture was inoculated to 10 ml of TT broth after adding 0.1 ml iodine into the TT broth, followed by incubation at 37 ± 1 °C for 24 h. After that, one loopful of the enriched culture taken from the TT broth was streaked on XLD agar while one loopful of the enriched culture taken from the RVS broth was streaked on BG agar, followed by incubation at 37 ± 1 °C for 24 h. On the XLD agar plates, yellow to red colonies with black centers colonies might represent the presence of *Salmonella* spp. in samples; on the BG agar colonies, the transparent, colorless or light pink colonies with color around from pink to light red were suspected to be *Salmonella* spp. When the