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The microbiological quality of ready-to-eat food in Siu Mei and Lo Mei shops in Hong Kong

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ABSTRACT

The safety of ready-to-eat food is an important issue. Improper handling of ready-to-eat food items may result in foodborne outbreaks. In this study, Chinese barbecued pork (Char Siu in Chinese) was selected as the target ready-to-eat food item for a microbial survey. The aim of this study was to evaluate the microbiological quality of Chinese barbecued pork sold in licensed Siu Mei and Lo Mei shops in Hong Kong. A total of 115 samples were collected from supermarkets or wet markets in the 18 districts. They were tested for aerobic plate counts (APC), *Escherichia coli* and *Staphylococcus aureus* counts, and the presence of *Salmonella* spp. for assessing their safety level. Results showed APC ranging from 1.97 to 6.84 log CFU/g, with a mean of 5.05 log CFU/g; *E. coli* counts ranging from none detected to 3.10 log CFU/g, with a mean of 1.78 log CFU/g; and *S. aureus* counts ranging from none detected to 1.42 log CFU/g, with a mean of 0.15 log CFU/g. The mean APC and *E. coli* counts of samples from supermarkets were found to be significantly lower than those from wet markets ($p < 0.05$) indicating that supermarkets had better microbiological quality than wet markets. *Salmonella* spp. were isolated from 39% of the samples analyzed, indicating that cross-contamination was quite a serious problem in Siu Mei and Lo Mei shops in Hong Kong. Based on these results, recommendations such as routine inspections and training of vendors were suggested to improve the microbiological quality of products sold in licensed Siu Mei and Lo Mei shops in Hong Kong so as to minimize risks of foodborne outbreaks.

1. Introduction

Ready-to-eat food is defined as food that can be consumed immediately at the point of sale without further preparation or treatment. It could be raw, partially or fully cooked, and hot, chilled or frozen (FEHD, 2007; USFDA, 2009). Ready-to-eat food can be animal food, plant food, fruits and vegetables, and bakery products (USFDA, 2009). Since ready-to-eat food is edible without additional treatment, risks of foodborne outbreaks are high if it is improperly handled.

Ready-to-eat food is highly subject to bacterial foodborne outbreaks. Various foodborne pathogens associated with ready-to-eat food have been found to contribute to foodborne outbreaks (Castro-Rosas et al., 2012; Seow, Ágoston, Phua, & Yuk, 2012). Methods of storage, processing, handling, and display can affect the levels of microorganisms in ready-to-eat food (Christison, Lindsay, & von Holy, 2008; Fang, Wei, Liao, Hung, & Wang, 2003). According to the statistics from the Centre for Health Protection of Hong Kong (CFS, 2012) from 2007 to 2011, bacteria were found to be the most common causative agents in foodborne outbreaks related to food premises and food businesses in Hong Kong (1827 out of 2303 outbreaks, 79.3%). Monitoring of the level of bacteria in ready-to-eat food is important to ensure the safety of this type of high-risk food.

Siu Mei and Lo Mei are two kinds of traditional Chinese processed meat or poultry products. Siu Mei refers to meat or poultry products processed by roasting at temperatures over 200 °C and Lo Mei refers to meat, poultry, or offal products that are prepared by simmering in large volumes of soy-based seasoning sauces. Siu Mei and Lo Mei can be categorized as ready-to-eat food because they

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can be consumed immediately at the point of sale without further preparation or treatment. Improper handling and treatments of Siu Mei and Lo Mei during display for sale can result in foodborne outbreaks (FEHD, 2001). The pathogens most commonly associated with Siu Mei and Lo Mei are *Salmonella* spp., *Staphylococcus aureus*, *Vibrio parahaemolyticus* and *Listeria monocytogenes* (CFS, 2009). *Salmonella* spp. are from humans or animals (WHO & FAO, 2002). Their presence in Siu Mei and Lo Mei is mainly due to cross-contamination with raw materials, or transmission from the hands of food handlers who have contacted contaminated raw materials, infected persons or animals, or fecal matter of infected persons or animals coupled with improper hand-washing (CHP, 2011; Le Loir, Baron, & Gautier, 2003; USFDA, 2012). It is most commonly transmitted to Siu Mei and Lo Mei from the hands of food handlers with poor personal hygiene practices. *V. parahaemolyticus* can be found in seafood and the marine environment (CHP, 2010; PHAC, 2011; USFDA, 2012). Its presence in Siu Mei and Lo Mei is mainly due to cross-contamination with raw seafood. *L. monocytogenes* can be found in the environment (CDC, 2011; USFDA, 2012). It is most commonly transmitted to Siu Mei and Lo Mei from the food processing environment or equipment.

Siu Mei and Lo Mei are common in Hong Kong and are widely available in wet markets, supermarkets, Chinese restaurants, and Chinese style fast food restaurants. The level of hygiene and safety of Siu Mei and Lo Mei sold in Hong Kong is thus very much a public concern. In the current study the microbiological quality of Siu Mei and Lo Mei sold in licensed Siu Mei and Lo Mei shops in Hong Kong was evaluated. Among the different types of Siu Mei and Lo Mei, Chinese barbecued pork was chosen as the representative ready-to-eat food in Siu Mei and Lo Mei shops for this study. To the best of our knowledge, this is the first report in the literature evaluating the microbiological quality of ready-to-eat food in Hong Kong.

2. Materials and methods

2.1. Sampling

Information on all the licensed Siu Mei and Lo Mei shops in Hong Kong was obtained from the Food and Environmental Hygiene Department of Hong Kong. The licensed Siu Mei and Lo Mei shops were first divided into 18 groups according to their location in the 18 official administrative districts in Hong Kong: “Central and Western”, “Eastern”, ”Southern”, “Wan Chai”, “Islands”, “Yau Tsim Mong”, “Sham Shui Po”, “Kowloon City”, “Wong Tai Sin”, “Kwun Tong”, “Tsuen Wan”, “Kwai Tsing”, “North”, “Tai Po”, “Sai Kung”, “Sha Tin”, “Tuen Mun”, and “Yuen Long”. They were then subdivided into two groups according to the types of shops, namely “supermarket” and “wet market”. After that, 25% of the total number of the licensed Siu Mei and Lo Mei shops in Hong Kong were randomly sampled by stratified sampling (Neyman, 1934). A total of 115 samples of Chinese barbecued pork were collected from randomly sampled Siu Mei and Lo Mei shops in Hong Kong over a period of two months from May to July 2012. Sample collection time was around 11:00 am–1:00 pm. Approximately 100 g of sample was purchased from each shop using the vendors’ own utensils and packaging materials. The samples collected were put into sterile plastic zipper bags and placed into insulation boxes with ice packs for transportation to the laboratory. The samples were transported from the place of purchase to the laboratory within 2 h, and analysis was carried out on the same day of sample collection. After arriving at the laboratory, the time of arrival was recorded and the temperature of each sample was measured with an infrared thermometer (MT-4012, Pro’sKit®, Taiwan). The samples were immediately transferred to a refrigerator (4 °C) and analyzed on the same date of sampling.

2.2. Evaluation of microbial counts

2.2.1. Preparation of materials

Phosphate buffered saline (PBS) for tests of aerobic plate counts (APC), *Escherichia coli* count, and *S. aureus* count was prepared (per litre) by dissolving 8.0 g NaCl (Sigma–Aldrich®, Germany), 0.2 g KCl (Sigma–Aldrich®), 1.44 g Na_2HPO_4 (Sigma–Aldrich®) and 0.24 g KH_2PO_4 (Sigma–Aldrich®) in MilliQ water (Dulbecco & Vogt, 1954). Buffered peptone water (BPW) for *Salmonella* pre-enrichment was composed (per litre) of 10.0 g peptone (BD BBL™ Phytone™ Peptone, France), 5.0 g NaCl (Sigma–Aldrich®), 3.6 g Na_2HPO_4 (Sigma–Aldrich®), and 1.5 g KH_2PO_4 (Sigma–Aldrich®) (ISO, 2003). Rappaport Vassiliadis Soya (RVS) Broth for *Salmonella* selective enrichment was prepared (per litre) according to the manufacturer’s instruction by dispersing 26.6 g Rappaport Vassiliadis Medium (Lab M, United Kingdom) in MilliQ water. Salmonella Shigella Agar (S.S. Agar) for isolation of *Salmonella* spp. was prepared with two brands of commercial S.S. Agar (Lab M, United Kingdom; and Oxoid, England).

2.2.2. Sample preparation

All the equipment was sterilized and the laboratory bench was disinfected before sample preparation. 25 g of each food sample was cut into small pieces with sterile scissors and transferred to Seward Stomacher® Bags and was 10-fold (1:9 *w/v* ratio) diluted with 225 ml of PBS. Samples were then homogenized at 200 rpm for 2 min using Seward Stomacher® 400 circulator. Each sample was tested in triplicate. The used samples were stored in a freezer below −4 °C.

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

3M™ Petrifilm™ Aerobic Count Plates, E. coli/Coliform Count Plates, and Staph Express Count Plates were used to enumerate the APC, *E. coli*, and *S. aureus* of the samples respectively. For APC enumeration, 10-fold (1:9 *w/v* ratio) and 100-fold (1:99 *w/v* ratio) dilutions of the resultant homogenate were prepared using PBS; for *E. coli* counts and *S. aureus* counts enumeration, only 10-fold (1:9 *w/v* ratio) dilution was prepared. Plating was done according to the manufacturer’s instructions. The plates were incubated in a horizontal position with the clear side up in stacks of no more than 5 plates in an incubator at 37 ± 1 °C. The incubation time for Aerobic Count Plates was 48 ± 3 h, and that for E. coli/Coliform Count Plates and Staph Express Count Plates was 24 ± 2 h. The results of APC were interpreted by counting the number of colonies on Aerobic Count Plates using a calibrated 3M™ Petrifilm™ Plate Reader according to the manufacturer’s instructions. The number of red-blue colonies associated with entrapped gas on E. coli/Coliform Count Plates was counted as *E. coli*, while the number of red-violet colonies on Staph Express Count Plates was counted as *S. aureus*.

2.2.4. Isolation of Salmonella spp.

For qualitative detection of *Salmonella*, 1 ml of homogenate was added from the Stomacher Bags to 10 ml of BPW, followed by incubation at 37 ± 1 °C for 24 h. Then, 1 ml of this pre-enrichment culture was added to 10 ml of RVS Broth, followed by incubation at 37 ± 1 °C for 24 h. After that, one loopful of the enriched culture was taken from the RVS Broth, streaked on S.S. Agar (Lab M, United Kingdom, and Oxoid, England) and incubated at 37 ± 1 °C for 24 h. The presence of black colonies on the S.S. Agar plates represents the presence of *Salmonella* in samples. When colonies on the plates were suspected to be *Salmonella*, Oxoid Salmonella Test Kit (DR1108A) was used according to the manufacturer’s instructions for the presumptive identification and confirmation of the presence of *Salmonella*.