Microbiological Investigation of Ready–to–cook Pork Bulgogi on Korean Markets

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Abstract

In this study, ready-to-cook (RTC) pork bulgogi was investigated microbiologically to determine contamination levels. The investigation was conducted because of an increasing trend in the consumption of RTC meat products in Korea. Ninety marinated RTC pork bulgogi samples were collected from major retail outlets (M), department stores (D), and local markets (L) in Seoul, Korea from March to June 2011. This study examined total plate counts (TPC), Escherichia coli, and coliform bacterial counts, and the presence of Bacillus cereus, Staphylococcus aureus, Listeria monocytogenes, Salmonella spp., and E. coli O157:H7. The mean TPC values were 5.89, 6.08, and 5.89 Log CFU/g for M, D, and L, respectively. E. coli was not detected in any sample, but coliforms were present in 72 (80%) of the 90 samples collected. B. cereus, E. coli O157:H7, and Salmonella spp. were not detected; however, S. aureus and L. monocytogenes were detected in five (5.5%) and one (1.1%) of the 90 samples. Samples collected from M and D were contaminated with S. aureus and those from L with L. monocytogenes. These results demonstrate that the conditions under which RTC pork bulgogi is handled and processed are unsanitary.

Key words: pork Bulgogi, ready-to-cook food, microbial safety, pathogens, Staphylococcus aureus, Listeria monocytogenes

Introduction

Pork bulgogi is a traditional Korean food. Thin slices of pork, usually arm picnic, shank, or ham, are marinated in a sauce containing soy sauce, onion, garlic, sesame oil and other seasonings. Pork bulgogi products can be contaminated with pathogenic bacteria during the handling or process if the raw materials used are contaminated or unhygienic conditions are applied. The ready-to-cook (RTC) product industry has expanded in Korea because of changes in customer consumption patterns. In Recent years, bulgogi is usually sold in markets as a RTC product. RTC foods, including bulgogi, are displayed open and exposed to contamination by bacterial pathogens; thus, several food-borne disease outbreaks have been associated with the consumption of contaminated RTC foods (Jo et al., 2003). Consumers find RTC products very convenient because these products only require heating to prepare a meal. However, the safety of these products during distribution and sale is frequently not monitored, and RTC bulgogi, in particular, is exposed to a serious risk of contamination or spoilage by bacteria in the ingredients, such as vegetables, soy sauce, and raw meat (Beuchat, 1996; Nguyen-the and Carlin, 1994). The number of cases of food-borne disease caused by the consumption of contaminated RTC food has been increasing. In 2010, 271 cases of food poisoning were reported, and 7,218 cases of food poisoning have been reported in Korea. The most frequent causes of bacterial food poisoning in Korea are contamination with pathogens such as Escherichia coli (28 cases), Salmonella spp. (27 cases) and Staphylococcus aureus (19 cases) (KFDA, 2010a).

E. coli strains rarely cause disease, except certain strains involved in infections of the intestinal and urinary tracts of humans. Pathogenic E. coli can be divided into six pathotypes: enterohemorrhagic (EHEC), enterotoxigenic (ETEC), enteropathogenic (EPEC), enterogaaggregative (EAEC), enteroinvasive (EIEC), and diffusely adherent (DAEC). Pathogenic E. coli has become a significant health concern especially E. coli O157:H7, having caused major outbreaks in food (Watterworth et al., 2005).

S. aureus has been recognized as an indicator of food hygiene. S. aureus is a public health concern because of...
its ability to produce enterotoxins and grow in highly saline environments. In cured meats, such as cured ham, which have a high pH, the water activity (a_w) should be below 0.90 for preventing the production of staphylococcal enterotoxin (Gillespie, 2007; Gormley et al., 2010).

Salmonella spp. are the most common pathogens associated with food-borne diseases, typhoid fever in humans, self-limiting enteritis, and fatal infections in animals. Red meat and poultry are good sources of Salmonella. In addition, improper process and equipment could be associated with increasing the probability of cross contamination with B. cereus and L. monocytogenes. B. cereus, a facultative anaerobic, spore-forming, motile bacterium has been identified as the causative agent of 2 types of gastrointestinal diseases (Ankolekar et al., 2009) and has been isolated from a wide variety of foods including spices (Choo et al., 2007; Konuma et al., 1988), ready-to-serve foods (Harmon and Kautter, 1991), and meat products (Smith et al., 2004).

Listeria spp., particularly Listeria monocytogenes have been recognized as animal pathogens for over 70 years (Suitho et al., 2002; Wesley, 1999). In the 1990s, L. monocytogenes was frequently isolated from all the major food products, such as unfermented dairy products (Ryser, 1999), cheese and meat products (Farber and Peterkin, 1999), and poultry and egg products. L. monocytogenes can survive in vacuum and gas-packed products and grow at refrigerated temperatures; this is a cause of concern for chilled meat products with an extended shelf-life.

The objective of this research was to evaluate the level of contamination of RTC meat products with pathogens on the major Korean markets, such as major retail outlets, department stores, and local markets. Pork bulgogi was chosen as the target RTC meat product and then the microbiological condition was investigated with the food hygiene indicator, such as TPC, E. coli, and coliforms as well as the presence of pathogens, such as B. cereus, E. coli O157:H7, S. aureus, Salmonella spp. and L. monocytogenes.

Materials and Methods

Sample collection

In total, 90 marinated pork bulgogi samples were collected from i.e., 3 samples each from 10 different major retail outlets (M), department stores (D), and local markets (L) located in Seoul, respectively, from March to June 2011 (Table 1). The collected samples were placed in sterile bags, transferred by refrigerated transport to the laboratory, and processed within 24 h of collection.

Food hygiene indicator bacteria

Testing for indicator organisms (total plate counts, E. coli, and coliform bacterial counts) has been introduced as a simple means of assessing the hygiene status of foods and helps ensure food safety (Park, 2004). The experimental procedure in our study was developed on the basis of the Korea Food Code (KFDA, 2010b). A 1:10 dilution sample of pork bulgogi was prepared by adding 25 g of meat sample obtained from a location to 225 mL 0.1% (w/v) peptone water; and the solution was homogenized in a stomacher (IUL instruments, Germany) for 2 min. Total plated counts, and E. coli and coliform bacterial counts were quantitatively assessed by inoculating the diluted samples on tryptic soy agar (TSA) plates and petrifilms (3M™), respectively, and incubating 35°C for 24 h.

Isolation and characterization of pathogens

B. cereus

Twenty-five grams of meat samples obtained from each location was added to 225 mL 0.1% peptone water and homogenized for 1 min. The mixed samples were inoculated on mannitol-egg yolk-polymyxin (MYP, Oxoid) agar and incubated at 35°C for 24 h. We isolated the pink-red mannitol-negative colonies with surrounding lecithinase-positive zones of precipitation streak-cultured the isolated colonies on TSA plated plates, and maintained these as pure cultures. The strains on the TSA plate cultures were then, analyzed biochemically by using API 50 CH strips (Biomériux, France).

E. coli O157:H7

Twenty-five grams of samples obtained from each location was added to 225 mL modified E. coli (mEC) medium with novobiocin as the antimicrobial supplement and incubated at 35°C for 24 h. The mixture was homogenized in a stomacher and mixed thoroughly. Inoculum were streaked on MacConkey sorbitol agar without cefixime and tellurite plates and incubated at 35°C for 16-

<table>
<thead>
<tr>
<th>Location</th>
<th>Number of places</th>
<th>Number of samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major retail outlet</td>
<td>10</td>
<td>30</td>
</tr>
<tr>
<td>Department store</td>
<td>10</td>
<td>30</td>
</tr>
<tr>
<td>Local market</td>
<td>10</td>
<td>30</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>30</strong></td>
<td><strong>90</strong></td>
</tr>
</tbody>
</table>

1/3 samples were collected from each place.