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Microbiological Quality and Safety Assessment of Commercial Ready-to-Eat Side Dishes Sold in Gyeonggi-do

Sun-Il Hwang, Sang-Tae Kim, Na-Eun Han, Yu-Mi Choi, Hye-Young Kim, Hyun-Kyung Ham, Chan-Mi Lee, Yong-Bae Park, Mi-Hui Son*

Microbiology Team, Gyeonggi-do Institute of Health and Environment, Suwon, Korea

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ABSTRACT - We aimed to analyze the microbiological quality of the ready-to-eat (RTE) side dishes collected from traditional markets, supermarkets, and cafeterias in Gyeonggi-do in 2019. A total of 108 samples were analyzed for total aerobic bacterial counts, coliforms and foodborne pathogens depending on place of purchase and cooking methods. Results show that *Bacillus cereus* was detected in 14 (12.9%) out of 108 samples of side dishes, while no other foodborne pathogens were detected. The mean detected level (range) of total aerobic bacteria depending on place of purchase was 5.8 log CFU/g (3.0 to 8.2 log CFU/g) for traditional markets, 4.3 log CFU/g (2.4 to 7.8 log CFU/g) for supermarkets, and 3.80 log CFU/g (0.0 to 6.8 log CFU/g) for cafeterias, indicating that there was a significant (P<0.05) difference in total aerobic bacterial counts among places of purchase. Among the samples, the highest counts of total aerobic bacteria and coliforms were detected in *saengchae* (raw vegetables), followed by *namul* (seasoned herbs, vegetables), *bokkeum* (stir-fried foods), and *jorim* (foods cooked in soy sauce). The growth of total aerobic bacteria in seasoned soybean sprouts was inhibited when the sprouts were stored at 4°C up to 24 h, whereas bacteria rapidly grew at 20 and 35°C after 3 and 6 h, respectively. These results reveal that storage temperature might play a significant role for the microbiological quality of seasoned soybean sprouts when they are sold in markets. Thus, this study suggests that RTE side dishes should be stored at refrigerated temperature when being sold at markets as well as after purchasing to improve their microbiological quality.

Key words : RTE side dishes, Food-borne pathogens, Traditional markets, Super markets, Cafeterias

In Korean society, a structural shift in consumption trends has recently emerged due to the alteration of social and economic structures, including the growing number of women engaging in an economic activity, a 52-hour workweek, higher income levels of customers, an aging population, and an increase in single-person households, not to mention the economic factors related to the slowdown in the spending boom[1,2]. As part of such changes, the categories of food intake have been subdivided, and goods and markets for ready-to-eat food (RTE) and home meal replacement (HMR) have dramatically diversified to meet the needs of customers who desire convenience and simplicity[3,4].

*Correspondence to: Gyenoggi-Do Institute of Health & Environment, 62, Chilbo-ro 1 beon-gil, Gwonseon-gu, Suwon-si, Gyeonggi 16444, Korea
Tel: +82-31-250-2542, Fax: +82-31-250-2605
E-mail: amas82@gg.go.kr

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In particular, the amount of HMR production including commercial RTE side dishes has seen an average annual growth of 9.7% since 2008, the year in which the relevant item category was established. With the growing consumption propensity to favor fully-cooked foods over partially-cooked foods, even the demand for fully-cooked foods purchased at stores, etc. or using the Internet, phone or delivery apps is also high. As of 2018, the size of HMR markets amounted to 1.941 billion dollars, up from 1.687 billion dollars (approximately 1.897 trillion won) in 2017. The growth rate centered around super supermarkets (SSM) and the retail industry is markedly increasing[5,6].

However, although RTE foods have advantages of time saving and convenience, there is a concern that customers may be exposed to foodborne pathogens, as they consume RTE foods without further heating and cooking process. Basically, most commercial RTE side dishes are displayed and stored in large quantities, and are weighed just before they are sold, or weighed and packed upon production. Since there is no further heating process for the elimination of contaminants prior to consumption of RTE side dishes, there

are at risk of mass food poisoning, which may emerge as a social issue[7,8].

Despite many advantages, when the hygiene and safety of food are not ensured, the RTE side dishes has no value. In that sense, food safety assurance should be taken seriously, as an important national policy. Every effort needs to be made to ensure food safety throughout the manufacturing, distribution, and purchasing stages[9]. As such, the establishment of hygiene standards related to foodborne harmful microbes is considered, which is essential for the prevention of foodborne outbreaks. Indeed, microbiological criteria and standards for RTE and convenience foods have been established and managed around the world.

With the growth of the side dish market due to changing consumption trends, there are also growing concerns among customers over the hygiene and safety management of commercial RTE side dishes. Therefore, this study aimed to identify the current status of food contamination through a microbiological hazard analysis of RTE side dishes being sold in Gyeonggi-do, and to present food management methods that will ensure the supply of safe foods so that customers can purchase RTE side dishes without any concerns.

Materials and Methods

Samples

A total of 108 samples of commercial RTE side dishes were collected from traditional markets, supermarkets, and cafeterias in Gyeonggi-do during a period from February to November, 2019. RTE side dishes were categorized based on the cooking method into *namul* (seasoned vegetable dishes), *bokkeum* (stir-fried dishes), *saengchae* (salad dishes made of fresh wild greens and seasonings), *jutgal* (salted, fermented dishes), and *jorim* (simmered dishes made by boiling vegetables, meat, fish, seafood, or tofu in a seasoned broth). Within one hour after purchase, they were transferred to the laboratory for analysis. All sampling and pre-treatment procedures were performed under aseptic conditions in a clean room. The samples used for analysis are presented in Table 1.

Analysis of food-borne pathogens

For the pre-treatment of the 108 samples, a 25 g sample was taken, put into 225 mL of tryptic soy broth (TSB; Oxoid, England), and homogenized for 30 sec using a blender (Seward, Newport, UK) for a 24-h enrichment culture at 36ºC, in accordance with the 'Food Poisoning Screening Method' specified in the 'Methods for Studies on Etiological Factors of Food Poisoning'[11]. After centrifuging 1 mL of enrichment at 13,000 rpm for 3 min, the supernatant was removed and 100 μL of sterile distilled water was added. After being boiled at 100ºC for 10 min, the suspension was centrifuged again at 13,000 rpm for 3 min. The supernatant obtained as a result of centrifugation was subjected to PCR analysis using template DNA.

To identify specific genes of 12 types of food-borne pathogens, Power Check™ Diarrheal *E. coli* 8-plex Detection Kit (Kogene Biotech, Seoul, Korea), Power Check™ Gram Positve Multiplex Detection Kit (Kogene Biotech), and Power Check™ Gram Negative Multiplex Detection Kit (Kogene Biotech) were used. After conducting PCR analysis as per the methods provided by each manufacturer, electrophoresis was used with QIAxcel DNA

Table 1. Categories of RTE side dishes

Category (No.)	Samples (No.)
Namuls[a] (39)	Pteridium aquilinum(4), Sesame leaf(2), Capsella bursa-pastoris(1), Balloon flower(4), Butterbur(1), Radish shreds(3), Oenanthe javanica(1), Ledebouriella seseloides (3), Amaranthus mangostanus L(2), Lettuce stem(1), Mung Bean Sprouts(4), Spinach(4), Radish greens(1), Crown Daisy(1), Pumpkin(1), Pimpinella brachycarpa(2), Aster scaber(1), Soybean sprouts(2), Seaweed fusiforme(1)
Bokkeums[b] (16)	Eggplant(1), Potato(2), Sweet Potato Stem(1), Balloon flower(1), Radish shreds(1), Pumpkin(3), Fish cake(4), Engraulis japonicus(1), Dried Squid(1), Sea mustard stem(1)
Saengchaes[c] (19)	Youngia sonchifolia Max(1), Codonopsis lanceolata(1), Garlic stem(2), Radish Kimchi(1), Radish Salad(3), Enteromorpha(1), Sesame leaf(1), Codonopsis lanceolata(1), Hot pepper(1), Hot pepper & soybean(1), Yulmoo Kimchi(1), Onion kimchi(1), Pepper & cucumber(1), Cucumber-kimchi(1), Cucumber preserved in brine(2)
Jutgals[d] (16)	Guts of Hairtail(1), Squid, Loligo Kobiensis(1), Nakjijeot(5), Alaskan pollack roe(1), Squid(3), Clam(2), Changran(3)
Jorims[e] (18)	Hot peppers(1), Peanut(1), Quail Eggs(3), Anchovy & egg(1), Shrimp(1), Beef(4), Glazed lotus root & burdock(1), Lotus roots(2), Burdock(1), Kodari(1), Soybean(2)
Total	108

[a] seasoned vegetable dishes; [b] stir-fried dishes; [c] salad dishes made of fresh wild greens and seasonings; [d] salted, fermented dishes; [e] simmered dishes made by boiling vegetables, meat, fish, seafood, or tofu in a seasoned broth.

High Resolution kit (QIAGEN, Hilden, Germany) and QIAxcel (QIAGEN) to verify results.

Foodborne pathogens, of which specific genes were identified through PCR analysis, were tested in accordance with the 'Microbiological Test Methods' specified in the Korean Food Standards Codex for identification and isolation of pathogens. The suspected colonies identified from each selective medium were inoculated to tryptic soy agar (TSA) depending on the characteristics of pathogens, and incubated at 30 to 37°C for 24 to 48 h. Then, bacteria were identified using VITEK 2 (Biomerieux, Paris, France)'s BCL VITEK 2 compact[12].

In addition, for the quantitative test for *B. cereus*, 200 μL of homogenate were spread plated on five Mannitol Egg Yolk Polymyxin (MYP) Agar plates (Oxoid). Following incubation at 30°C for 24 h, the number of pink colonies, which had a zone of whitish precipitate and broken down lecithinase, was selectively counted. Five or more typical colonies were selected from the counted plates, inoculated to the Nutrient Agar plate (Difco, New York, NY, USA), and incubated at 30°C for 24 h. Then, Gram staining was performed, and the bacteria identified as Gram-positive bacilli with spores were verified through biochemical testing (VITEK2). The total bacterial count was calculated by multiplying the identified plate count by the dilution factor[11].

Analysis of hygienic indicators

A 25 g of the sample and 225 mL of sterile physiological saline were placed into a sterile stomacher bag and homogenized with the stomacher for 1 min. Aerobic bacteria, coliforms, and *Escherichia coli* were analyzed as per '4. Microbiological Test Methods of 8. General Tests' specified in the Korean Food Standards Codex. To calculate the total aerobic bacteria, each 10× serial diluent was prepared from 1 mL of test solution using sterile diluent (3M™ Diluent, 3M, St. Paul, MN, USA). Then, 1 mL of the diluent was inoculated to at least two sheets of dry rehydratable film media (3M Petrifilm™, 3M) per dilution phase and incubated at 35°C for 24 to 48 h. The number of red colonies with gas formed as a result was counted, and the total aerobic bacteria were calculated by multiplying the average number of colonies by the dilution factor.

In order to test coliforms, 1 mL of the pre-treated sample was taken and diluted per phase ranging from 10^{-1} to 10^{-7}. Each 1 mL of the diluted sample was inoculated to at least two sheets of dry rehydratable film media (3M Petrifilm™ CC; 3M) for coliforms and incubated at 35°C for 24±2 h. Among the red colonies formed as a result, the number of colonies with bubbles around them was counted.

As for Escherichia coli, each 1 mL of the sample diluted per phase was inoculated to at least two sheets of dry rehydratable film media (3M PetrifilmTM EC; 3M) for *Escherichia coli* and incubated at 35°C for 24±2 h. Among the blue colonies formed as a result, the number of colonies with bubbles around them was counted.

Analysis of microbial changes depending on storage method

To identify microbial changes depending on the storage method used for RTE side dishes, seasoned soybean sprouts were purchased. They were kept at 4°C in a refrigerator (MPR-721-R-PK, Panasonic, Osaka, Japan) for cold storage; in a 20°C incubator (JP/MIR-154, Sanyo, Osaka, Japan) for room-temperature storage; and in a 35°C incubator (US/311, Forma, New York, NY, USA) for high-temperature storage. Analysis was performed at 3, 6, 9, 24, 48, and 72 h after purchase.

Statistical analysis

In this study, microbial count was represented as log CFU/g, and a significant difference ($P<0.05$) among samples was verified by performing Duncan's multiple comparison of means with a post-hoc test through one-way ANOVA and independent sample T-test using SPSS 12.0K for Windows (SPSS Inc, Chicago, IL, USA).

Results and Discussion

Analysis of rates of contamination in commercial side dish samples

As shown in Table 2, *B. cereus* was detected in 14

Table 2. Food-borne pathogens in RTE side dishes

Food-borne pathogens (12 Group)	Detection No.
Pathogenic *Escherichia coli*	ND[1]
Listeria monocytogenes	ND
Clostridium perfringens	ND
Staphylococcus aureus	ND
Salmonella spp.	ND
Yersinia enterocolitica	ND
Campylobacter jejuni/coli	ND
Vibrio parahaemolyticus	ND
Vibrio cholerae	ND
Vibrio vulnificus	ND
Shigella spp	ND
Bacillus cereus	14
Total (108)	14

[1] ND : not detected.

(12.9%) out of a total of 108 samples, but no other pathogens were detected. More specifically, *B. cereus* was detected in 3 samples purchased from traditional markets, 5 samples from supermarkets, and 6 samples from cafeterias. Looking at contamination based on the cooking method, *B. cereus* was detected in 3 samples of *namul,* 9 samples of *saengchae*, and 2 samples of *jutgal*, but not detected in *jorim* and *bokkeum*. According to the results of a quantitative analysis of the detected *B. cereus*, lettuce stems accounted for the largest share at 2.5 log CFU/g, followed by *changran* at 2.4 log CFU/g, *yulmoo kimchi* at 2.3 log CFU/g, garlic stems at 2.3 log CFU/g, etc. The results were verified to be appropriate, because *B. cereus* is ≤ 4 log CFU/g in *jutgal* and ≤ 3 log CFU/g in *saengchae* and *namul*, considering the criteria and standards for *B. cereus* applied in the Korean Food Standards Codex: *B. cereus* ≤ 10,000/g in *jutgal* (Criteria and Standards for General Foods); ≤ 1,000/g in RTE foods (Criteria and Standards Per Food). *B. cereus* is widely detected in grains and vegetables, and is known to be usually detected within the range of 10^1 to 10^3 CFU/g in general foods[13].

Andersson et al.[14] reported that when *B. cereus* are present at ≥ 10^3 to 10^4 CFU/g, there is at risk of food poisoning. *B. cereus*, which is widely distributed in the natural world, contaminates a wide range of foods, including dried agricultural products, vegetables, grains, etc. In particular, it causes a risk of food poisoning due to deterioration during distribution, as it is a spore-forming bacterium that re-multiplies in an appropriate environment by creating a biofilm with a strong adhesion. In addition, *B. cereus* is not completely inactivated in the process of heat treatment as part of manufacturing, because of the formation of endospores. Since surviving spores could be germinated and vegetative cells could multiply again under certain conditions, it is considered potentially hazardous to eat raw foods[20].

Inspection of hygienic indicators in commercial RTE side dishes

Microbial Contamination Rates Depending on Place of Purchase

Bacterial count is the most representative indicator of the degree of microbial contamination in foods, and is significant in a comprehensive assessment of food safety and hygienic handling, etc[21].

As shown in Table 3, the results of tests on total aerobic bacteria according to place of purchase indicate that the average detected level (range) was 5.8 log CFU/g (3.0 to 8.2 log CFU/g) for traditional markets, 4.3 log CFU/g (2.4 to 7.8 log CFU/g) for supermarkets, and 3.8 log CFU/g (0.0 to 6.9 log CFU/g) for cafeterias, suggesting that place of purchase has a significant influence. Six samples from traditional markets and one from a supermarket had a detected level > 7 log CFU/g[16], the reference value indicating entry into the spoilage phase.

Table 3. Contamination rate of total aerobic bacteria in samples (Unit : No. of samples)

	Contamination rate of total aerobic bacteria in samples					
Place	<4[1]	4-7[1]	>7[1]	Min[1]	Max[1]	Mean±SD[1]
Traditional market	3[2]	16	6	3.0	8.2	5.8±1.5[b]
Supermarket	12	12	1	2.4	7.8	4.3±1.4[a]
Cafeteria	11	14	0	0.0	6.9	3.8±1.7[a]

[1]Unit : log CFU/g.
[2]Number of samples.
[a,b] Means with different superscripts in the same column differ significantly.
(P<0.05 ; one-way ANOVA and DUNCAN's multiple range test).

Table 4. Contamination rate of coliform in samples (Unit : No. of samples)

	Contamination rate of Coliform in samples						
Place of purchase	0[1]	0-3[1]	3-5[1]	>5[1]	Min[1]	Max[1]	Mean±SD[1]
Traditional market	11[2]	7	2	5	0.0	6.1	2.1±2.3[b]
Supermarket	18	5	1	1	0.0	5.6	0.8±1.5[a]
Cafeteria	19	5	1	0	0.0	4.1	0.5±1.1[a]

[1]Unit : log CFU/g.
[2]Number of samples.
[a,b] Means with different superscripts in the same column differ significantly (P<0.05 ; one-way ANOVA and DUNCAN's multiple range test).

As shown in Table 4, the average detected levels (ranges) of coliforms were 2.1 log CFU/g (0.0 to 6.1 log CFU/g) for samples from traditional markets, 0.8 log CFU/g (0.0 to 5.6 log CFU/g) for samples from supermarkets, and 0.5 log CFU/g (0.0 to 4.1 log CFU/g) for samples from cafeterias, suggesting a significant difference depending on place of purchase. *E. coli* was not detected in any samples.

The total aerobic bacterial and coliform counts in the RTE side dishes being sold in Gyeonggi-do revealed that the current hygienic conditions of traditional markets were not adequate compared to supermarkets and cafeterias. While coliforms are not pathogens their detection provides an indicator of the potential presence of pathogenic bacteria such as *Salmonella* and *Shigella* belonging to Enterobacteriaceae[17]. As well, *E. coli* is an indicator organism of fecal pollution in terms of food hygiene[19,20].

Microbial contamination rates depending on cooking method

The contamination rates of total aerobic bacteria depending on cooking method are presented in Table 5. For *saengchaes*, the mean of total aerobic bacteria was 6.1 log CFU/g with a range of 4.9 to 7.84 log CFU/g. A total of 15 samples of *saengchaes* had a total aerobic bacteria ≥ 4 log CFU/g, and this number was larger than other cooking method groups. According to the report of Seo et al.[19] which analyzed fruit and vegetable salads with no heating process like *saengchaes*, the mean of total aerobic bacteria in salad samples was found to be 5.4 log CFU/g. In general, *saengchaes* require special caution as they need no separate heat treatment when multiple types of raw materials are mixed together and are relatively more likely to be contaminated due to factors including raw materials, cooking utensils, the hands of the cook, and exposure to the external environment in the sales process.

The mean of total aerobic bacteria in *namuls* was 5.2 log CFU/g, which was the second-highest level, with a range of 2.9 to 8.2 log CFU/g. A total of 3 cases were found to exceed 7 log CFU/g. The report of Jeon et al.[20] indicated that in a microbial test on the production process of seasoned soybean sprouts, total aerobic bacteria and coliforms were not detected just after soybean sprouts were boiled, but when the boiled soybean sprouts were cooled down in front of an electric fan at room temperature for 45 min, refrigerated for 1 h, and then cooked and distributed, the total aerobic bacteria and coliforms exceeded the reference value of microbes. Kim et al.[22] and Hur et al.[23] reported that the vegetables used for cooked vegetable dishes were re-contaminated by microbes over time. This suggests that special caution should be exercised in cooking vegetable dishes. In the case of *namuls*, the initial microbial count was small because of the heat treatment process, but the softening process of tissues facilitated bacterial penetration and growth, thus leading to the active proliferation of food-borne pathogens over time. For this reason, it is considered important to eat Namuls as soon as possible after purchase, compared to other RTE side dishes.

As for *jutgals*, the mean (range) of total aerobic bacteria was 3.9 log CFU/g (2.2 to 6.0 log CFU/g), and there was no sample > 7 log CFU/g. The total aerobic bacteria of *jutgals* was lower than that of *saengchaes*, *namuls*, and *bokkeums*, which is probably because of the salts' inhibitory effect on microbial propagation. While in Korea there are no regulations on the total aerobic bacteria in *jutgals*, as marine bacteria, halophilic bacteria, yeasts, etc. derived from raw materials are present, the total microbial count usually found in salt-fermented fishery products is 10^3 to 10^5 log CFU/g[24]. Meanwhile, according to UK specifications on total aerobic bacteria, microbial quality is "satisfactory" if the total microbial count in raw pickled fishes, similar to Korean *jutgals*, is ≤ 10^3 CFU/g; is "acceptable" at 10^3 to 10^4 CFU/g; and is "unsatisfactory" at ≥ 10^4 CFU/g[20].

The range of total aerobic bacteria in *jorims* was 0.0 to

Table 5. Contamination rate of total aerobic bacteria in samples (Unit : No. of samples)

	Contamination rate of total aerobic bacteria in samples					
Cooked group	<4[1]	4-7[1]	>7[1]	Min[1]	Max[1]	Mean±SD[1]
Namuls	4[2]	8	3	2.9	8.2	5.2±1.6[bc]
Bokkeums	4	9	2	2.7	8.2	5.0±1.6[b]
Saengchaes	0	13	2	4.9	7.8	6.1±0.9[c]
Jutgals	7	8	0	2.2	6.0	3.9±1.1[a]
Jorims	11	4	0	0.0	5.2	3.0±1.6[a]

[1]Unit : log CFU/g.
[2]Number of samples.
[a,b,c] Means with different superscripts in the same column differ significantly.
(P<0.05 ; one-way ANOVA and DUNCAN's multiple range test).

Table 6. Contamination rate of coliform of samples (Unit : No. of samples)

	Contamination rate of coliform of samples						
Cooked group	0[1)]	0-3[1)]	3-5[1)]	>5[1)]	Min[1)]	Max[1)]	Mean±SD[1)]
Namuls	7[2)]	4	3	1	0.0	5.4	1.9±2.0[bc]
Bokkeums	9	5	0	1	0.0	5.6	1.2±1.7[b]
Saengchaes	3	7	1	4	0.0	6.1	2.8±2.3[c]
Jutgals	14	1	0	0	0.0	1.0	0.1±0.3[a]
Jorims	15	0	0	0	0.0	0.0	0.0±0.0[a]

[1)]Unit : log CFU/g.
[2)]Number of samples.
[a,b,c)] Means with different superscripts in the same column differ significantly.
(P<0.05 ; one-way ANOVA and Duncan's multiple range test).

5.2 log CFU/g, and *jorims* showed the lowest mean value at 3.0 log CFU/g. As with *jutgals*, there was no sample > 7 log CFU/g, and 11 samples were < 4 log CFU/g, accounting for the majority of samples. These results are deemed to be attributed to bacterial destruction resulting from addition of much salts and long-term heating. This is agreement with the report of Kim et al.[25)] that the total microbial counts in *jorims*, etc. were low. In addition, Yoo et al.[26)] reported that the total aerobic bacteria and coliforms in 8 types of *jorims* with a heating process were found to be below the reference values. Such results were interpreted to be due to the destruction of a considerable amount of bacteria in the cooking process.

The levels of coliforms depending on the cooking method are shown in Table 6. *Saengchaes* had the highest mean value at 2.8 log CFU/g, and 4 cases exceeded 5 log CFU/g. The mean coliforms level was the second highest at 1.9 log CFU/g in *namuls*, followed by 1.2 log CFU/g in *bokkeums* and 0.1 log CFU/g in *jutgals*, but coliforms were not detected in all samples of *jorims*.

The mean detected level of total aerobic bacteria and coliforms was highest in *saengchae* and *namul*, followed by *bokkeum*, *jutgal*, and *jorim*. When it comes to *saengchaes* with no heating process and *namul*, in which bacterial penetration is facilitated by their softening tissues in the process of cooking, it is recommended to eat them as soon as possible after purchase. Regarding *bokkeum*, which are highly heated in the cooking process, *jutgal* with the antimicrobial activity of salts, and *jorims* that are cooked over high heat for an extended period of time, long-term storage is considered possible because the initial microbial count is relatively small.

Thus, our examination of the current status and problems of hygiene of commercial RTE side dishes, which were identified through this survey, is followed by suggestions regarding food management methods based on the survey results.

In some stores, RTE side dishes were being sold on stands at room temperature, not on refrigerated stands, and there was no transparent cover to prevent airborne bacteria from falling on them. Even if they have such a cover, RTE side dishes were frequently exposed to the external environment because they were scooped out whenever purchased. In addition, the risk of cross-contamination due to physical contact (mainly hand contact) by the seller was also high. In particular, RTE side dishes sold in bulk were easily exposed to dust in the air and harmful microbes. In the event of food poisoning, it would be unclear whether it was because of a problem occurring in the manufacturing or in the distribution process. Meanwhile, if the stored foods are not discarded at an adequate time or are mixed with new foods for sale, there is a high risk of food contamination due to the difficulty in distinguishing between stored products and new products. The possibility of microbial contamination cannot be ruled out in any of the stages involving distribution, washing, and cooking of raw materials because hand contact by the cook is inevitable. Pre-sales storage methods, sales methods, post-consumption storage methods, etc. also act as influential factors[27,28)]. In this regard, the US Centers for Disease Control and Prevention (CDC) also reported that cooking utensils contaminated by microbes and poor hygiene of the cook can cause mass food poisoning[29)].

In supermarkets, RTE side dishes were being stored in covered containers in refrigerator. Some of the products were scooped out of these containers whenever they were purchased, but many of them were being displayed in individual wrappings. As for cafeterias, each of the RTE side dishes was sealed in a disposable container immediately after it was cooked and stored on refrigerated stands. RTE side dishes from department stores L and supermarkets E, N and L, which are similar to the places of purchase in the survey by Hwang et al.[30)] on food poisoning-causing contamination rates in the commercial RTE side dishes purchased around Seoul, were individually packed and

displayed in refrigerators. RTE side dishes from traditional markets K and E were individually packaged or scooped out of the transparent containers up to the amount desired by the customer.

To prevent microbial contamination in the RTE side dishes sold in bulk, it is considered that a certain amount should be individually stored in standardized packaging containers with a shelf life indicated in an adequately refrigerated, sealed system, immediately after they are produced. Also, contamination with food-borne pathogens and bacteria indicating a sanitary problem can also be prevented through sterilization of the raw materials, contamination prevention in the cooling process after heat cooking, contamination prevention on transporting, packaging, and display, cold storage, etc.

Assessment of microbiological quality depending on storage temperature and time

The results of changes in total aerobic bacteria per storage temperature of seasoned soybean sprouts are as presented in Fig. 1. When seasoned soybean sprouts were stored at 4°C, the total aerobic bacteria, which was 4.7 log CFU/g at an early stage, was shown as 4.7 log CFU/g after 9 h, suggesting that there was little change over time, but there were changes in bacterial count later, reaching 5.2 log CFU/g after 48 h and 5.8 log CFU/g after 72 h. However, when stored at 20°C, the change in total aerobic bacteria dramatically increased beginning at 6 h after the start of storage, from 4.7 log CFU/g to 5.2 log CFU/g after 6 h and to 7.8 log CFU/g after 9 h. When stored at 35°C, the change in total aerobic bacteria was dramatic beginning at 9 h after the start of storage, when it exceeded 7 log CFU/g, the reference value indicating entry into the spoilage phase[16] — from 4.7 log CFU/g to 5.0 log CFU/g after 3 h, to 6.5 log CFU/g after 6 h, and to 8.7 log CFU/g after 9 h.

Changes in coliforms in seasoned soybean sprouts at each storage temperature are shown in Fig. 2. When the seasoned soybean sprouts were stored at 4°C, an increase in coliforms was observed, from 1.30 log CFU/g to 3.7 log CFU/g after 72 h. When stored at 20°C and 35°C, an increase to 3.3 log CFU/g after 9 h and to 3.6 log CFU/g after 6 h were observed.

The change in microbiological quality in seasoned soybean sprouts was small even after 72 h of cold storage (4°C) after purchase, but the possibility of decomposition was increased after 9 h at room temperature (20°C) and after 6 h at high temperature (35°C). Therefore, when purchasing Namuls, it is desirable to keep them refrigerated just after purchase or to eat them entirely as soon as possible if you are keeping them at room temperature.

Consequently, if kept refrigerated at 4°C, RTE side dishes

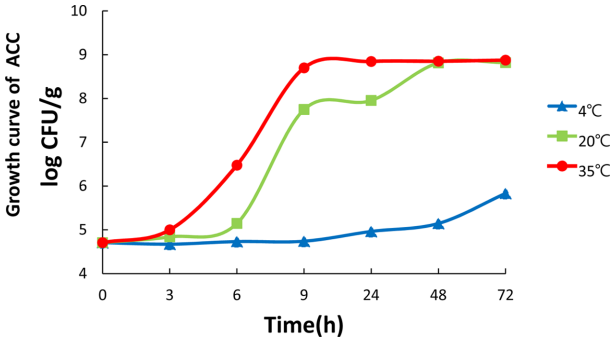

Fig. 1. Changes of total aerobic count cell (ACC) in seasoned soybean sprouts during storage at 4, 20, and 35°C for 72 h.

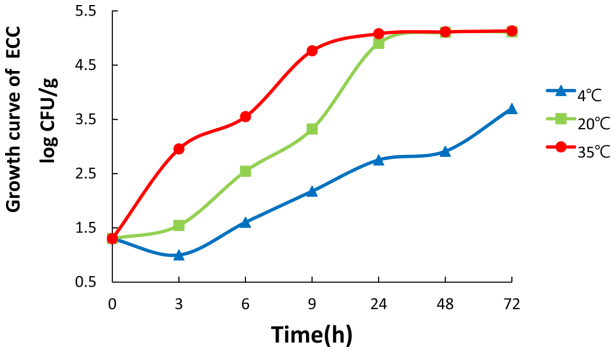

Fig. 2. Changes of coliform count cell (ECC) in seasoned soybean sprouts during storage at 4, 20, and 35°C for 72 h.

can be consumed safely even after long-term storage, but caution is required when storing at room temperature (20°C) or high temperatures (35°C). In particular, special caution should be exercised with regard to microbial contamination in the summer season with a high average temperature, by storing products on refrigerated and sealed stands. If the initial microbial count is high even at 20°C, spoilage can be reached quickly. In that sense, cold storage of products just after production is deemed to be necessary; indeed, it is only through cold storage that the growth rate of bacteria can be delayed for a certain period of time.

국문요약

2019년 경기도내 전통시장, 대형마트, 반찬전문점에서 수거한 반찬류의 미생물 품질을 조사하였다. 반찬류 108건의 식중독 원인균을 검사하였고, 그 중 75건에 대해서는 구매 장소별, 조리 방법별 위생세균 검사를 진행하였다. 14건(12.9%)에서 *Bacillus cereus*가 검출되었으며, 나머지 94건에서는 식중독 원인균이 검출되지 않았다. 위생세균 검사에서 일반세균의 평균 검출량(범위)은 전통시장이 5.8 log CFU/g (3.0-8.2 log CFU/g), 대형마트는 4.3 log CFU/g

(2.3-7.8 log CFU/g), 반찬전문점에서는 3.8 log CFU/g (0.0-6.9 log CFU/g)로 나타났으며, 구입 장소에 따른 유의적인 차이가 있었다(P<0.05). 전통시장의 일반세균수와 대장균군은 대형마트, 반찬점과 통계적으로 유의한 차이가 있었고, 생채류, 나물류, 볶음류, 젓갈류, 조림류 순으로 일반세균수와 대장균군이 높게 검출되었다. 콩나물 무침의 보관온도별 일반세균수의 변화는 냉장보관(4°C)에서는 72시간 경과에서도 큰 변화가 없었으나, 상온보관(20°C) 및 고온보관(35°C) 시 구입 후 각각 9시간, 6시간 경과 시 부패의 가능성이 제기되어 구입 즉시 냉장보관 할 것을 권장하며, 제품을 판매하는 시설에서도 냉장보관을 하여야 할 것이다.

Conflict of interests

The authors declare no potential conflict of interest.

ORCID

Sun-Il Hwang	https://orcid.org/0000-0002-1097-7099
Sang-Tae Kim	https://orcid.org/0000-0002-8366-9062
Na-Eun Han	https://orcid.org/0000-0001-7693-2769
Yu-Mi Choi	https://orcid.org/0000-0001-7863-2591
Hye-Young Kim	https://orcid.org/0000-0001-5795-0582
Hyun-Kyung Ham	https://orcid.org/0000-0003-2426-4441
Chan-Mi Lee	https://orcid.org/0000-0002-6871-0143
Yong-Bae Park	https://orcid.org/0000-0003-2596-8520
Mi-Hui Son	https://orcid.org/0000-0002-3841-4861

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