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Distribution Strategies for Food Safety in the Foodservice Industry: Microbial Contamination of Beverages and Cakes

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Abstract

Purpose: This study investigated the microbial status of beverages and desserts containing strawberries sold at coffee outlets in Busan, South Korea. The study sought to identify differences in types of foodservice management and microbial status of beverages and desserts. **Research design and methodology:** This study compared microbial status between franchised and single-unit outlets via microbial laboratory tests. In addition, impact of risk factors on microbial status were investigated. We analyzed the data using independent t-tests and chi-square tests. In order to measure the impact of risk factors on microbial status, multiple regression was run. We expected franchised outlets to be more likely to apply food safety practices than single-unit outlets. **The principal results:** Results of microbial testing showed that franchised outlets had a higher microbial status than single-unit outlets. The results showed that franchise outlets were more inclined to adhere to food safety practices than single-unit outlets when it comes to total number of bacteria however for coliform group results showed otherwise. **Major conclusions:** These study results suggest that a standard food safety and sanitation manual for coffee outlets is needed, especially for single-unit coffee outlets. The current inspection items should be revised accordingly to ensure customer safety.

Keywords: Foodservice Distribution**;** Food Safety; Government Policy; Foodservice Management; Consumer Protection

JEL Classification Code : L83, M53, D18, E29, I18

1. Introduction

According to a report by the KB Financial Group (KB financial group, 2019), Korea is one of the third-largest global market for coffee shop businesses, behind only the United States and China. In 2013-2018, the industry grew almost 13% annually, with an 83.88% increase during that period. The number of coffee franchise stores increased by 43.8%, from 1.1 million in 2014 to 1.5 million in 2018. Nearly 23.3% of all coffee shops in Korea were franchise stores in 2018. Popular coffee franchises in Korea include Starbucks Coffee, Ediya Coffee, A Twosome Place, Mega Coffee, and Pascucci, and bakery cafe franchises include Paris Baguette and Tous Les Jours.

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Distribution of foodservice is important in terms of food safety and consumer satisfaction since microbiological contamination is a significant food-safety challenge (Alves et al., 2021). The presence, persistence, replication, and/or toxin production of pathogenic microorganisms in food is a major concern for consumers, the food and beverage industries, and regulatory agencies worldwide (Tropea, 2022). Bacterial pathogens are the most commonly found food and beverage contaminants, followed by viruses, pesticide residues, and mycotoxins (Van Boxstael et al., 2013). Harmful bacteria on food surfaces increase the risk of cross-contamination, leading to food poisoning and potential food losses (Tropea, 2022). It is crucial to adhere to food safety in food manufacturing and production to prevent microbiological contamination, which can cause significant morbidity and mortality among consumers (Elkhishin, 2017; Tropea, 2022). Maintaining food safety and quality is critical for food security and moving food appropriately in the local, national, and global markets (Bosona & Gebresenbet, 2013; Bryden, 2012). However, maintaining food safety at proper level all time may be challenging since foodservice industry involves variability by staff. This variability might be maximized when handling fresh fruits. Among most used fruits, strawberries are one of the popular ingredients for beverages and cakes in foodservice establishments. However, strawberries are difficult to use due to its short self-life. It is not unknown that strawberries are seldom washed for cake decoration. Therefore, this study measured food safety of beverages and cakes containing strawberries.

The purpose of this study is to examine food safety level of beverages and cakes containing strawberries sold at foodservice outlets in Republic of Korea. In order to investigate the food safety status, this study used microbial tests. This study will provide importance of food safety at foodservice establishments in particular handling fruits.

2. Literature Review

2.1. Distribution of Foodservice and Cleanliness

Consumer behaviors and satisfaction have been at the focus of research in the foodservice industry. The recent pandemic brought food safety issues and considered more importantly than any other issues in the foodservice industry. As consumers became more anxious about food safety, food handling practices became a crucial factor in foodservice distribution area. Therefore, consumers want to know how food is prepared and cooked by the staff. The cleanliness of the foodservice outlets, including the kitchen, is an essential factor for consumers to visit the place (Aksoydan, 2007). It is difficult to detect bacterial and viral contaminations by visual assessment, the lack of microbiological analysis can be problematic to judge the cleanliness. The results of previous studies using hygiene swabs and agar contact plates have found that visual assessment of the cleanliness is a poor indicator of food safety (Griffith et al., 2000; Moore & Griffith, 2002).

However, it is not general to conduct microbiological assessment of foodservice outlets unless there is foodborne illness outbreak occurs. Previous studies have found that food safety issues can negatively influence consumers when they purchase products in a foodservice environment (Hecht & Martin, 2006; Vilnai-Yavetz & Gilboa, 2010; Zemke et al., 2015). Centers for Disease Control and Prevention (2011) acknowledged that hands transmit almost 80% of all infections. The foodservice industry should take good care of such transmission, as food and beverages prepared and served are involved with human contact.

2.2. Food Safety of Food and Beverages

Coffee shops offer coffee, other hot and cold beverages, breakfast items, sandwiches, salads, cakes, desserts, and other snacks on-site. All coffee shops should uphold food hygiene and safety standards (CPD, 2023). Efficient process controls and effective food safety management systems can reduce microbiological contamination and improve food security (Elkhishin, 2017). Hygiene standards in the food and beverage industry and serving establishments must be assessed to control and prevent foodborne diseases (Bukhari et al., 2021), especially in countries with rapidly growing food and beverage industries (Sirichokchatchawan & Somrongthong, 2020).

In Korea, strawberries are one of the most popular fruits for cakes, shaved ice, sandwiches, and beverages, such as fruit juice, smoothies, teas, and lattes. In 2021, Mega Coffee sold more than 180,000 cups of four strawberry drinks within three weeks of the product's launch. Ediya Coffee sold more than 700,000 cups of three strawberry drinks within three months of its release (Yogiyo, 2021).

However, hygienic monitoring in Korean coffee shops is voluntary. Coffee franchise headquarters conduct regular inspections and hygiene training, but the number of violations of the Food Sanitation Act is steadily increasing (Gu et al., 2021). According to the Ministry of Food and Drug Safety, there were 856 Food Sanitation Act violations at major franchise coffee shops in Korea from 2014-2018, with 153 violations in 2014, 154 in 2015, 165 in 2016, 178 in 2017, and 206 in 2018 (The Korea economic daily, 2019). The most common violation was 'not completing hygiene education,', with 267 cases, followed by 'violation of sanitary handling standards' (102 cases) and 'mixing of foreign substances' (71 cases) (The Korea economic daily, 2019).

Variability in preparing and serving food and beverages are common in food service industry. The distribution of food service delivery should follow manuals of the food service outlets in order to reduce possible contaminations in food service delivery. Therefore, this study defined the distribution of food service delivery as the appropriate food service practices to consumers.

This study investigated food safety in beverages and cakes containing fruit such as strawberries. We collected beverages and desserts from single-unit and franchised coffee shops and performed laboratory analyses to verify microbial contamination. We divided the collected data by outlet type to determine differences in microbiological contamination in order to identify the differences in foodservice distribution.

3. Research Methods and Materials

3.1. Sample Collection and Preparation

We sampled beverages and desserts at 28 outlets, including 14 franchise and 14 single-unit outlets, in Busan, South Korea. Trained investigators collected strawberry beverages and strawberry desserts for microbial analyses from each outlet and transferred them to Pukyong National University in an insulated ice cooler within 4 hours. Bacterial enumeration methods for total bacterial, coliform, and *Escherichia coli* (*E. coli*) were performed following the food industry standards (Korea food and drug administration, 2009). Strawberry chunks from the beverage samples were transferred to a sterile pack, homogenized, and mixed for 10 min. Strawberries (approximately 25 g) from desserts were cut with sterile scissors and a knife and then transferred to a sterile pack. The samples were homogenized for 2 min. All of the extractions were performed in duplicate.

3.2. Microbial Test

To enumerate the total bacteria, coliform group, and *E. coli* in the samples, we performed microbial tests using dry film (6400 for the aerobic count plate, 6410 for the coliform count plate, and 6404 for the *E. coli*/coliform count plate, 3M Petrifilm, St. Paul, MN, USA) per the manufacturer's instructions (Elvira et al., 2014). Test solutions (1 mL) of each 10-fold serial dilution were inoculated onto the dry film media and cultured at 35°C for 48 hours for the total bacteria, 24 hours for the coliform group, and 24-28 hours for *E. coli* (Alegbeleye et al., 2018; Jang et al., 2013). All of the enumeration analyses were performed in duplicate.

3.2. Data Analysis

We coded data into EXCEL and analyzed it using the Software Package for the Social Sciences for Windows (version 23, 2019; SPSS Inc, IL, USA). Data from franchised outlets were coded as '1' and from single units were coded as'0'. Bacteria and coliform counts were analyzed as $\log_{10}$ bacteria (LB) and $\log_{10}$ coliform (LC). We used the independent t-test to compare the microbial contamination of strawberry beverages and desserts by outlet type. We ran a Chi-square test if there were any differences between franchised and single-unit outlets regarding environmental or human risk factors. We ran multiple regression analyses to determine the impact of risk factors on the microbiological evaluation.

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4. Results and Discussion

4.1. Total Number of Bacteria and Coliform Groups by Types of Food Service Outlets

We collected the data from 28 outlets for beverages and 20 outlets for cakes. Table 1 shows the microbial test results by beverages and cakes. We counted bacteria in most samples, and coliform form in some of the samples. *E-coli* was not found in any sample.

Table 1: Results from microbial test by subject

Samples	Strawberry beverage		Samples	Strawberry cake	
	Total bacteria	Coliform group		Total bacteria	Coliform group
F1	6800	0	F1	7653	173
F2	6850	0	F3	62	0
F3	19950	0	F4	4	0
F8	1550	60	F6	136974	0
F9	2685	325	F7	1323661	0
F10	29	0	F10	0	0
F11	1	0	S14	32432	176
F12	80000	50	F15	459677	0
F13	2500	5	S16	639	0
F15	30000	100	F17	4545	23
F18	39	0	F18	1560	634
F19	4	0	S20	254	0
S20	23156	984	S22	15762	0
F21	100	0	S26	8616	10076
S22	6800	160	F27	54957	66
S23	150	0	S35	80720	0
S24	22650	400	S36	1510	0
S25	44	10	S38	28	0
F27	12	0	S39	161644	0
S28	13800	980	S40	416	0
S29	50	5	-	-	-
S30	9750	9	-	-	-
S31	0	0	-	-	-
S32	13800	0	-	-	-

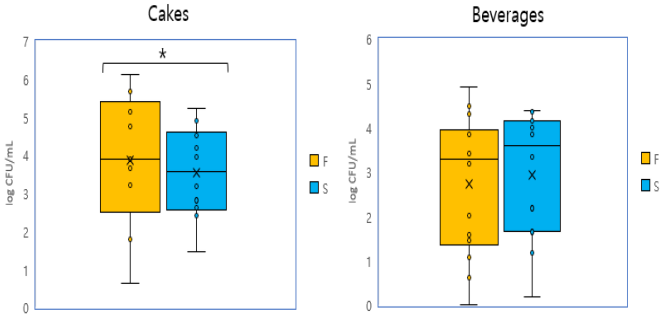
S33	0	0	-	-	-
S34	2	0	-	-	-
S35	2200	0	-	-	-
S37	15	0	-	-	-

We compared the total number of bacteria and coliform by outlet type (Table 2). LB found in strawberries sold at single-unit outlets was not statistically different from those sold in franchise outlets, while LC found in strawberries sold in single-unit outlets was significantly different from those sold in franchise outlets. LC found in SB at single-unit outlets showed higher than franchise outlets. LB was statistically different by outlet type. Franchise outlets had higher LB counts than single-unit outlets. We found no significant difference in LC by outlet type, but the LC count in strawberries sold in single-unit outlets was higher than those sold in franchises.

Table 2: Results of t-test from Microbial Test Results of Total Bacteria and Coliform Group by each Study Subject

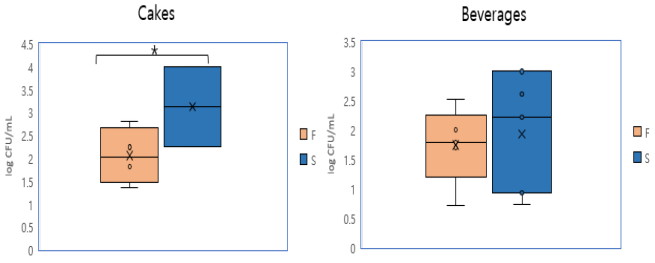
Test	Total bacteria			Coliform group		
	Mean ± Standard Deviation					
Sample	Single-unit	Franchise	t-value	Single-unit	Franchise	t-value
SB	3.82±3.92	4.03±4.32	0.662	2.26±2.54	1.59±1.93	-1.462**
SC	4.48±4.70	5.30±5.60	1.260*	3.01±3.48	1.95±2.28	-0.928

Note: Measurement (log CFU/g or CFU/ml)
*$p < 0.05$, **$p < 0.01$



Note: *p < 0.05

Figure 1: Boxplot of of log_{10} bacterial count in cakes and beverages by types of outlets



Note: *p < 0.05

Figure 2: Boxplot of of log_{10} coliform group count in cakes and beverages by types of outlets

4.2. Overall Results of the Risk Factor Assessment

We measured food safety practices based on food safety evaluations (Appendix 1). We modified and reorganized the items from governmental sanitation inspections for food service establishments. Most of the environmental risk factors met these sanitation guidelines, except for sanitation certificates. Only 10% of the outlets in the study sample received sanitation certificates. Items meeting the criteria included a clean interior of the establishment (89.6%), a bright food preparation area (97.9%), and a clean food preparation area (91.7%). Regarding human risk factors, the criteria of some staff wearing a mouth mask (54.2%), having clean fingernails (97.9%), wearing chef's clothes or an apron (77.1%), and having clean chef's clothes, apron, or uniform (89.6%) were ranked as satisfactory. Items ranking unsatisfactory in the evaluations included staff wearing a sanitation hat or hair protection (22.9%), a sanitary mask (45.8%), and separate staff making beverages/food and receiving payment (10.4%).

4.3. Associations of Food Safety Practices by type of Foodservice Outlets

The Chi-square results demonstrate risk factor differences between single-unit and franchise outlets. For environmental risk factors, receiving sanitation certificates differed by outlet type (Chi-square = 5.581, $p < 0.05$). For human risk factors, staff wearing a sanitary mask (Chi-square = 5.371, $p < 0.05$), staff not wearing a hat or hair protection (Chi-square = 5.779, $p < 0.05$), and staff not wearing jewelry showed differences (Chi-square = 5.371, $p < 0.05$).

4.4. The Impact of Risk Factors on Microbiological Evaluation

We ran multiple regression analyses to find the impact of risk factors on microbiological evaluations. We first ran risk factors against LB, but the model did not show statistical significance (F = 1.969, $p = 0.065$, $R^2 = 0.396$, adjusted $R^2 = 0.195$). The results of the multiple regression showed that only one risk factor, receiving a food sanitation certificate, showed a significant impact on LB (B = -1.889, t = -2.426, $p = 0.021$). We then ran the risk factors against LC (Table 3). The model showed significance at $p > 0.05$ (F = 4.072, df = 9, $p = 0.30$). For the environmental risk factors, interior cleanliness ($p < 0.01$) and cleanliness of the beverage and food preparation area ($p < 0.05$) affected the LC. For human factors, staff wearing chef's clothes or

aprons ($p < 0.05$) and staff not wearing jewelry impacted the LC ($p < 0.05$).

Table 3: Results of Regression of Risk Factors on LC

Measurements	B	Std. error	Beta	t-value
Constant	1.230	1.180		1.042
Interior of establishment was clean	2.674	.699	.972	3.828**
Food preparation area was clean	-2.065	.673	-.751	-3.069*
Food preparation area was properly bright enough	.514	.639	.136	.803
Staff was wearing sanitary mask	-.520	.358	-.301	-1.453
Staff was wearing sanitation hat or hair protection	.680	.440	.327	1.544
Staff was wearing chef's cloths or apron	-1.423	.497	-.614	-2.864*
Chef's cloths, apron or uniform was clean	.584	.639	.155	.914
Staff was not wearing jewelries	1.204	.423	.697	2.844*
Staff who was making beverage and receiving payment was divided.	-.744	.546	-.270	-1.362

Note: R = .906, R^2 = .821, Adjusted R^2 = .619
*p < 0.05, **p < 0.01

5. Discussion

This study investigated hygiene level of beverages and cakes containing strawberries regarding the distribution of foodservice delivery. Food safety issues are critical matters for both consumers and food service providers. Food service establishments must adhere to food sanitation guidelines to avoid possible foodborne illnesses and outbreaks. However, the Food Code provided by the Korea Ministry of Food and Drug Safety (KMFDS) applies to factory-made food or that packaged for retail. The Food Code does not apply to food and beverages prepared and served at food service establishments. It also ignores the environmental and human risks that play critical roles in food safety issues at foodservice facilities. This study used not only microbial tests but also as an assessment of both environmental and human risks to measure if food service establishments meet the KMFDS food sanitation guidelines.

These results suggest that food service environments and human factors affected microbial food contamination (Buckalew et al., 1996; Jang et al., 2013; Montiville & Schaffiner, 2004) in the distribution of foodservice deliveries. A previous study found that cutting, shredding, and mixing foods and beverages may affect microbiological contamination (Cenci-Goga et al., 2005; Hedberg et al., 1991; Jang et al., 2013). It was found that about 55% of foodborne illnesses were caused by improper cooking and storage and 24% were attributable to poor personal employee hygiene (Cenci-Goga et al., 2005). Interestingly, this study showed that food service outlets that received food sanitation certificates had a better microbiological status. The current food sanitation certificate system began in 2017 and is voluntary. In addition, the certificate categorizes establishments as "excellent," "very good," and "good," which do not offer consumers much distinction. The voluntary standing may hinder food service providers from getting the certificates (Kim & Choi, 2021). Regarding human factors, wearing sanitation masks, sanitation hats, or hair protection and not wearing jewelry differed between single units and franchised outlets. These human factors should be checked to avoid contamination of food and beverages prepared by staff. Cross-contamination could occur when preparing or storing ready-to-eat foods (Bsadjo Tchamba et al., 2016; Little et al., 2003).

Comparisons of single-unit and franchised food service establishments suggest that food sanitation practices must be practiced regardless of the type of food service provider. For cakes, the total number of bacteria was higher in franchised than in single-unit outlets. For beverages, the number of coliform groups was higher in single units than in franchised outlets. This may be due to human risk factors, such as inadequate staff training. For beverages, single-unit outlets had more coliform groups, which may be due to the beverage materials. Single units purchase beverages from vendors other than, franchises, which receive materials according to their contract. Variations in beverage materials require additional sanitation considerations, as food materials have different handling requirements (Bsadjo Tchamba et al., 2016; Jang et al., 2013; Little et al., 2003). Both single-unit and franchise outlets use frozen strawberries, as frozen fruits are much cheaper than fresh fruits. However, frozen fruits may have higher levels of coliform groups due to differences in washing requirements.

Single-unit outlets must pay attention to the food materials they use and should practice food sanitation accordingly. For instance, traditional beverages with specific food materials should adhere to sanitation rules according to the food materials (Gu et al., 2021). This also implies that food handling warrants training expertise in food service areas, since single units might not adopt systemized training manuals, while franchises often have a regular sanitation inspection per headquarters. Food service establishments in which managers receive food hygiene training have fewer unacceptable samples compared to those with no training (Little et al., 2003). Also, smaller food service establishments have more hygiene issues, suggesting the need for more frequent inspections (Little et al., 2003).

However, food handling manuals for franchisees may vary as there are no specific rules provided by KMFDS. Currently, the lack of food codes for foods prepared and provided by food service establishments warrants government involvement (Sugianti et al., 2019). KMFDS

provides food codes for food packaged and provided at food service establishments. Foodservice establishments follow the food codes for retail packaged foods, which have big gaps between different foods and beverages. Specialty beverages could be potential sources of pathogenic bacteria if sanitation practices are not implemented (Bsadjo Tchamba et al., 2016).

6. Conclusion

This study was the first attempt to examine the microbial quality of beverages and cakes using strawberries in comparisons between single-unit and franchised food service establishments regarding distribution of foodservice deliveries. Significant differences were found in beverages and cakes sold in single units and franchised outlets in terms of microbial quality and environmental and human risk factors. Results of microbial tests suggested both single-unit and franchised foodservice establishments should pay attention to food safety issues when it comes to handling food ingredients such as strawberries. Risk factors could be controlled by food hygiene practices and food handling training. Single-unit outlets in particular need systemized training and manuals. Foodservice establishments warrant governmental involvement, as there is no food code for foods prepared and provided at these facilities.

There are some limitations to this study. First, the study sample was collected in a limited area in Busan, Republic of Korea, and the results may not be generalizable as single units might demonstrate variation according to food hygiene certificate or training issues. Second, the samples were collected in May, and seasonal variations may exist due to temperature differences. Further study should account for seasonal variations in the distribution of foodservice deliveries. Lastly, this study measured microbial quality in terms of the number of bacteria and coliform groups. Future studies should include the specific quality of coliform to elucidate cause and outcomes.

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Appendix 1. Contingency table analysis of unsatisfactory ratios of total coliforms in strawberry contain beverages and sanitation evaluations

Risk factor	Guidelines	Evaluation n (%)	Single-unit n (%)	Franchise n (%)	Chi-square	P-value
environment	Interior of establishment was clean	Unsatisfactory 5 (10.4)	1 (20)	4 (80)	2.009	0.156
		Satisfactory 43 (89.6)	23 (53.5)	20 (46.5)		
	Food preparation area was properly bright enough	Unsatisfactory 1 (2.1)	1 (100)	0 (0)	1.021	0.312
		Satisfactory 47 (97.9)	23 (48.9)	24 (51.1)		
	Food preparation area was clean	Unsatisfactory 4 (8.3)	2 (50)	2 (50)	0.000	1
		Satisfactory 44 (91.7)	22 (50)	22 (50)		
	Received sanitation certificate from the government	Unsatisfactory 43 (89.6)	24 (55.8)	19 (44.2)	5.581*	0.018
		Satisfactory 5 (10.4)	0 (0)	5 (100)		
Human	Staff was wearing mouth guard or mask	Unsatisfactory 22 (45.8)	15 (68.2)	7 (31.8)	5.371*	0.020
		Satisfactory 26 (54.2)	9 (34.6)	17 (65.4)		
	Staff was wearing sanitation hat or hair protection	Unsatisfactory 37 (77.1)	22 (59.5)	15 (40.5)	5.779*	0.016
		Satisfactory 11 (22.9)	2 (18.2)	9 (81.8)		
	Staff has clean finger nails	Unsatisfactory 1 (2.1)	1 (100)	0 (0)	1.021	0.312
		Satisfactory 47 (97.9)	23 (48.9)	24 (51.1)		
	Staff was wearing chef's cloths or apron	Unsatisfactory 11 (22.9)	6 (54.5)	5 (45.5)	0.118	0.731
		Satisfactory 37 (77.1)	18 (48.6)	19 (51.4)		
	Chef's cloths, apron or uniform was clean	Unsatisfactory 5 (10.4)	3 (60)	2 (40)	0.223	0.637
		Satisfactory 43 (89.6)	21 (48.8)	22 (51.2)		
	Staff was not wearing jewelries	Unsatisfactory 22 (45.8)	15 (68.2)	7 (31.8)	5.371*	0.20
		Satisfactory 26 (54.2)	9 (34.6)	17 (65.4)		
	Staff who was making beverage and receiving payment was divided.	Unsatisfactory 43 (89.6)	20 (46.5)	23 (53.5)	2.009	0.156
		Satisfactory 5 (10.4)	4 (80)	1 (20)		

Note: * $p < 0.05$