**Evaluation of Food Safety Related Behaviours of Retail and Food Service Employees While
Handling Fresh and Fresh-Cut Leafy Greens**

Jihee Choi¹; Hillary Norwood²; Soobin Seo^{1*}; Sujata A. Sirsat²; and Jack Neal²

¹Hospitality Management, The Ohio State University 1787 Neil Avenue, Columbus, Ohio 43201

²Conrad N. Hilton College of Hotel and Restaurant Management, University of Houston 229 C.
N. Hilton Hotel and College, , Houston, TX 77004

*Corresponding Author

Soobin Seo, Ph.D.

Assistant Professor

Hospitality Management, The Ohio State University

1787 Neil Avenue, Columbus, Ohio 43201

E-mail: seo.190@osu.edu

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ABSTRACT

Foodborne illness outbreaks are often associated with fresh and fresh-cut produce (specifically leafy greens); however, effective training and methods of prevention have not been readily available for the retail and food service industry. The objective of this study was to assess and evaluate the current state of compliance and employee handling practices for fresh and fresh-cut produce, and to identify factors influencing employees' fresh and fresh-cut handling practices using an observational survey tool. A total of sixteen restaurants and fifteen grocery stores in Texas and Ohio were observed. The results revealed low compliance of employees' leafy green handling practices such as improper use of thermometers, lack of documentation, and poor employee hygiene. Statistical analysis results suggested that employees' food safety behaviours vary based on several factors such as operation size, cuisine, and operation type. The results of the study will provide practical guidelines for training employees handling leafy green produce at fresh and fresh-cut packing facilities, produce distribution centers, grocery stores, and restaurants.

Keywords: Fresh leafy green produce, Employee handling practices, Food safety behaviours, Food service establishments, Observational method

1. Introduction

The retail and food service industry has the ever-present challenge of providing safe food to its consumers. According to the National Restaurant Association (NRA), 12.8 million employees in the United States (U.S.) serve over 70 billion meals at 960,000 commercial operations each year (National Restaurant Association, 2011). Additionally, prepared foods/meals sales continue to grow for grocery and convenience stores, and are an emerging market for big box food retailers. Unfortunately, the increase in consumers' spending at restaurants is directly proportional to increasing risks of contracting a foodborne illness which may be unknowingly transmitted by food handlers (Redmond & Griffith, 2003).

Fresh and fresh-cut leafy green produce have been implicated in multiple foodborne illness outbreaks (Neal et al., 2012). In fresh leafy green produce alone (cabbage, lettuce, spinach, sprouts, herbs, leafy green salads and coleslaw), there were approximately 100 U.S. outbreaks due to *Salmonella* spp., *E. coli* O157:H7, *Shigella* spp., and *Campylobacter jejuni* reported between 2000 and 2007 (Anderson, Jaykus, Beaulieu, & Dennis, 2011). Changes in consumption patterns, production and processing technologies, and new sources of produce have all contributed to the increase in produce-related outbreaks. However, one must ask, have the retail and food service industries kept pace with regard to food safety practices and training? The connections between pathogens and produce are complex with the likelihood of contamination occurring at three critical periods: (1) in the field, (2) initial processing, and (3) at final preparation in the kitchen (Lynch, Tauxe, & Hedberg, 2009). The process of cutting, shredding, and slicing, releases nutrients making them available to pathogens which may lead to high microbial counts that can make produce inherently more risky once cut, requiring additional care in handling and storage afterwards (Lynch et al., 2009). Due to such potential risks caused by improper handling of ready-to-eat (RTE) foods that are prepared in retail and food service establishments (e.g. deli salads and deli meats), government regulatory agencies are focusing more on the farm to fork continuum of fresh and fresh-cut leafy green produce. For example, the U.S. Food and Drug Administration (FDA) (2010) encouraged retail food establishments to review the guidance for the temperature control of fresh and

fresh-cut leafy green produceduring storage and display for reducing the risk of foodborne to illness to consumers.

The fresh and fresh-cut leafy green produce industry continues to grow rapidly into a multi-billion dollar segment of the produce industry (Rico, Martin-Diana, Barat, & Barry-Ryan, 2007). This is due in part to consumers' busier lifestyles. Consumers are preparing less food at home, have the perception of fresh-cut leafy green produce being healthy, and expect to have fresh-cut produce year-round (Garrett et al., 2003). The food service industry is responding to consumers' health concerns (e.g. obesity) by providing healthier meal options such as fresh-cut fruits and salads. In addition, as a means to decrease costs, mostly labor costs, and waste with regard to meal preparation, the food service industry has significantly increased their use of pre-cut products (Shwedel & Costa, 2004).

The FDA Food Code (2013, p. 5) defined the fresh-cut leafy greens as "fresh leafy greens whose leaves have been cut, shredded, sliced, chopped, or torn. The term "leafy greens" includes iceberg lettuce, romaine lettuce, leaf lettuce, butter lettuce, baby leaf lettuce (i.e., immature lettuce or leafy greens), escarole, endive, spring mix, spinach, cabbage, kale, arugula and chard."The processing steps (e.g. cutting, slicing, peeling, shredding) destroy cell surfaces and the exposure to cytoplasm may provide a better source of nutrients for microorganisms compared to intact produce, which can facilitate rapid microbial growth (Beuchat, 1996; Barry-Ryan, Pacussi, & O'Beirne, 2000; Francis et al., 2012).Complicating matters, much of the fresh-cut leafy green produce is consumed raw which, therefore, provides no thermal death treatment to combat pathogenic microorganisms. A study conducted by Sirsat and Neal (2013) indicated that fresh-cut Romaine lettuce (bagged salad) has equal if not higher levels of bacteria than whole lettuce heads. In addition, many leafy green productsare outsourced from a variety of sources including local farms, which are often promoted as a safe alternative (Erenwert, 2012). While food safety guidelines have been well-documented for fresh and fresh-cut leafy green produce processors (Garrett et al., 2003; Gory, 2001), few training materials exist for restaurants and grocery store employees specifically concerning this unique segment.

Therefore, this study aimed to evaluate the current state of compliance and handling practices for fresh and fresh-cut leafy green produce in retail and food service operations using observational data. Better understanding of food safety practices will help identify and ensure that proper food handling practices of fresh and fresh-cut leafy green produce will become an integral part of preparing and serving food safely. Likewise, based on these results, factors influencing food safety practices will be identified to help develop behaviour-based training materials that are task-specific, which may ultimately result in reduced incidences of retail and food service-originated foodborne illnesses associated with fresh and fresh-cut leafy green produce.

2. Methods

2.1. The sample

Prior to data collection, the University Human Subjects Institutional Review Board (IRB) approved the study materials, including the research protocol and questionnaire. Grocery stores and restaurants were selected as retail and food service establishments either preparing fresh and fresh-cut produce or using modified atmosphere packaging (MAP) products purchased from other suppliers including local farms and corporate distributors such as Dole. A list of grocery stores and restaurants in Houston, Texas and Columbus, Ohio were reviewed in terms of operation size (i.e., number of stores and sales dollars) as well as ownership (i.e., chain and independent) in order to select representative samples. A total of sixty stores were contacted via phone or visit to identify their eligibility to participate in the study. To verify the eligibility for participation, recruiters first identified whether the establishments handled fresh and fresh-cut produce (e.g., preparing fresh and fresh-cut leafy green produce or using MAP products purchased from other suppliers). If the establishments met this criteria, the recruiters requested their participation in the study and arranged to visit the establishments to conduct an on-site observation of food workers handling fresh and fresh-cut leafy green produce. Restaurants and grocery stores that did not prepare and serve fresh and fresh-cut leafy green produce were not included in the sample.

2.2. Data collection procedure

Prior to the collection of data, an initial informational interview was conducted with the retail manager or person in charge (PIC) who served as the researchers' contact person for each operation. The purpose of this interview was fact finding, which included questions regarding: the type of food safety training presently being used for fresh and fresh-cut leafy green produce, types of fresh and fresh-cut leafy green produce used in the operation, form(s) of fresh and fresh-cut leafy green produce received into the operation (e.g. fresh whole heads, precut, prepackaged), how the fresh and fresh-cut leafy green produce was handled once inside the operation (e.g. washing, stock rotation, handling during preparation and serving), policies and procedures being used for hand washing, glove usage, sick employees, and cleaning and sanitizing of work surfaces and equipment.

Data was collected over a six-month period and a total of 15 grocery stores and 16 restaurants in Houston, Texas and Columbus, Ohio participated in the study. The length of observation was approximately consistent for all of establishments, which took approximately 20 minutes to observe establishments' fresh and fresh-cut leafy green produce handling practices. As an attempt to minimize the time-pressure effects, researchers visited operations when businesses were slow or before opening hours when they were preparing leafy green produce. Each recruited operation was evaluated in terms of food safety handling practices of fresh and fresh-cut produce, specifically leafy greens using the developed observational assessment. Only one observer in each city was allowed to perform observations in order to ensure the consistency throughout observations. Due to the distance of the two locations, the researchers were not able to have parallel observations, therefore inter-observer reliability was not calculated. In order to ensure consistency between two observers, one trained researcher visited both Houston and Columbus to train observers on how to observe employees' handling practices of fresh and fresh-cut produce.

2.3. Observational assessment

158 Researchers reviewed each operation's practices and standard operating procedures (SOPs) for
159 food handling and preparation of fresh and fresh-cut leafy green produce and observed whether the
160 operation's procedures and practices were being followed. Items of observation were derived from
161 Gibson et al. (2013) to evaluate employees' food handling practices for preparing fresh and fresh-cut
162 leafy green produce. The assessment tools were pilot tested at a local grocery store and restaurant that did
163 not participate in this study and appropriate adjustments were made based on the pilot test results prior to
164 administration. For example, one of the warewashing components in the original instrument (Gibson et al.,
165 2013) did not specify the exact level of chemical ppm and temperature requirements, thus researchers
166 decided to observe their practice of using chemicals rather than verifying the exact level of ppm and
167 temperature.

168 This study used two assessment tools: (1) fresh and fresh-cut leafy green produce handling
169 practice assessment and (2) general food safety assessment following the guideline of Gibson et al. (2013).
170 The assessment for fresh and fresh-cut leafy green produce handling practices was composed of 35
171 evaluated items. These items were divided into eight categories: 1-receiving (i.e. use of thermometer to
172 check the temperature of product in the receiving process); 2-storage (i.e. cooler cleanliness); 3-
173 production steps (pre-prepping; i.e. handling RTE foods using utensils or wearing gloves); 4-product use
174 (i.e. checking labels to make sure product is still within use by date limits); 5-cool storage (i.e. proper
175 temperature of display units); 6-display for consumer use (i.e. use of clean and sanitized units); 7-self-
176 serve bar (i.e. proper rotation of produce on cold bar); and 8-employee (i.e. employees' appropriate
177 washing hands). The general food safety assessment consisted of 44 items which were divided into eight
178 categories as follows: 1-food temperature/time control/preparation (i.e. how often check temperature); 2-
179 personnel (i.e. washing hands); 3-food handling/source (i.e. appropriate flow of food); 4-food preparation
180 (i.e. use of SOPs); 5-facility (i.e. location of hand washing sink); 6-service/food bars (i.e. changing
181 containers properly); 7-storage (i.e. food is stored at least 6" above floor); and 8-ware washing (i.e.
182 temperature documentation of manual washing). The assessment tools allowed observers to record "Yes"

when each practice/behaviour is exhibited and well-executed, “No” when each practice/behaviour is not exhibited or not properly executed, or “N/A” when each practice/behaviour is unobservable or unavailable.

In order to evaluate the observed practices of food handlers, a scoring system was derived following the guidance of da Cunha, Stedefeldt, and de Rosso (2014). When a practice was correctly performed by a food handler, one point was awarded (coded as 1). In contrast, one point was deducted when each practice was incorrectly followed (coded as -1). Additionally, when a practice was unavailable or unobservable, no point deduction was made and the specific item was considered as “non-applicable” (coded as 0). The awarded points were summed up at the end, and the higher (lower) score indicated the higher (lower) compliance rate of food safety practices to the guideline, enabling researchers to quantify the level of food safety practices at retail and food service operations.

2.4. Data analysis

Statistical analyses were performed using the Statistical Package for Social Science (SPSS version 18.0). Descriptive statistics including mean, standard deviation, and percentage were used to summarize the data. Independent t-tests were conducted to examine factors influencing fresh and fresh-cut leafy green produce handling practices and general food safety practices that include operation size (number of employees ≤ 10 vs. > 10), cuisine (ethnic operated vs. non-ethnic operated¹), and operation type (grocery store vs. restaurant).

3. Results

3.1. Descriptive statistics

A total of 15 grocery stores and 16 restaurants were recruited in Houston, TX and Columbus, OH. As shown in Table 1, the majority of establishments (76%) had standard operating procedures for the

¹Ethnicity is associated with or belonging to a particular group of race of people who have a different culture from the main culture of a country (Katz & Weaver, 2003).

handling of fresh and fresh-cut leafy green produce. In terms of types of fresh and fresh-cut leafy green produce, 61% of respondents used heads of lettuce, 12% used only pre-cut leafy greens, and 27% used both in their establishment.

[Insert Table 1]

3.2. Evaluation of food handlers' fresh and fresh-cut leafy green produce handling practices

Food handlers were observed when preparing fresh and fresh-cut leafy greens and then recorded using an observational tool (Gibson et al., 2013) as demonstrated in Table 2. With regard to receiving practices, the observational results showed that only 58% of establishments consistently calibrated thermometers (which was coded as N/A if they used a digital thermometer) and 45.2% of establishments did not document temperatures while receiving fresh and fresh-cut leafy green produce. In contrast, most establishments followed appropriate storage practices. For example, it was observed that more than 90% of establishments' coolers were clean and items were stored at least six inches off the floor at a temperature of 41°F or below. During production steps, while more than 80% of establishments seemed to appropriately equip the facility (e.g. prep sink or table) for keeping fresh and fresh-cut leafy green produce safe, only 58% of the employees appropriately washed their hands, put on gloves, or properly handled RTE foods. With regard to labeling in both product use and cold storage, most establishments followed proper practices for fresh and fresh-cut leafy green produce. For example, 83.9% of establishments checked labels (indicating date of preparation) before use to ensure that the product was still within date limits and discarded out-of-date products. Specifically, in case of whole head leafy greens requiring for cut and wash, the prepared date was marked. In comparison, the "use by date" was employed for MAP bag leafy green products. However, in some operations, even though it was already cut and triple washed, they voluntarily washed the MAP bagged greens to refresh. In such case, the washed green produce was marked with prepared date. In the cold bar sections, 64.5% of the establishments stored fresh and fresh-cut leafy green produce properly at the end of the day to be reused

for the next day and 61.3% used utensils properly for produce. In addition, it was observed that approximately half of the establishments' employees did not record the cooler's temperature every four hours on the monitoring logs as the documentation process.

[Insert Table 2]

3.3. Evaluation of food handlers' general food safety practices

A general food safety assessment was performed for all observed establishments (Table 3). With regard to food temperature, most establishments showed good practices in ensuring temperature of leafy green products (93.5%, at 41°F or below) to reduce the risk of pathogen growth that is recommended by the FDA Food Code (2013). However, temperature was not recorded as frequently as recommended which was consistent with leafy green observation results. More specifically, 45.2% of establishments did not check food temperatures every 4 hours and 41.9% of establishments did not calibrate thermometers to check temperatures. With regard to food handling and preparation practices, 93.5% of establishments showed proper practices of food labeling, dating, and rotating, and 90.3% showed well-maintained sanitization practices of their work space and equipment. One thing to be noted is that although all observed establishments were fully equipped with hand washing stations with paper towels and soap (96.8%), only about a half of the employees showed proper hand washing behaviours during the observation. In terms of storage practices, although most foods were stored in proper containers (93.5%), only 74.2% of establishments separated raw foods from cooked foods in separate refrigeration units or stored raw foods beneath cooked foods in the same refrigerator to reduce the risk of cross-contamination. Lastly, with regards to ware washing, although 90.3% of establishments were equipped with appropriate ware washing facilities, only 12.9% and 16.1% documented manual and mechanical washing chemical sanitizing concentrations (ppm) or sanitizing temperatures, respectively.

[Insert Table 3]

3.4. T-test of observed fresh and fresh-cut leafy green produce handling practices

A series of t-tests were performed to identify factors influencing the food handlers' fresh and fresh-cut leafy green produce handling practices. In terms of leafy green handling practices, there were statistically significant differences depending on cuisine ($t(11)=-2.485, p=0.030$) (Table 4), supporting that non-ethnic (American) establishments displayed higher leafy green handling practice scores compared to that of ethnic establishments. While the differences in overall leafy green handling practice scores considering other factors except for cuisine were not found to be statistically significant, some categorical differences were found to be significant depending on operation size and cuisine (Table 5). Categorically, small establishments showed higher leafy green handling practice scores compared to large operations in terms of storage ($t(27)=2.227, p=0.034$), display for consumer use ($t(15)=2.272, p=0.038$), and employee hygiene ($t(27)=2.471, p=0.020$). Non-ethnic establishments (American) showed higher fresh and fresh-cut leafy green produce handling practice scores compared to that of ethnic establishments in terms of storage ($t(12)=-2.497, p=0.027$), cool storage ($t(29)=-2.298, p=0.029$), display for consumer use ($t(11)=-2.996, p=0.012$), and employee hygiene ($t(29)=-2.759, p=0.010$).

[Insert Table 4 & Table 5]

3.5. T-test of observed food safety assessment

Overall, the level of general food safety practices was found to vary depending on operation type ($t(23)=3.499, p=0.002$), indicating that grocery stores ($M=30.13$) exhibited higher scores in terms of general food safety practices compared to restaurants ($M=14.00$) based on our scoring process (Table 6). Categorically, non-ethnic establishments compared to ethnic establishments showed higher food safety practice scores in terms of food preparation ($t(29)=-2.373, p=0.025$). Grocery stores categorically had higher scores in terms of temperature ($t(29)=3.444, p=0.002$), personnel ($t(21)=4.334, p=0.000$), food handling ($t(14)=3.224, p=0.006$), food preparation ($t(29)=2.143, p=0.041$) and storage ($t(22)=2.411, p=0.025$) (Table 7).

[Insert Table 6 & Table 7]

4. Discussion and Conclusions

This study examined employees' current food safety practices for handling fresh and fresh-cut leafy green produce in retail and food service establishments. Observational results suggest that there are a number of challenges that need to be addressed to ensure correct handling of fresh and fresh-cut leafy green produce in these establishments. The current study found numerous incidents of noncompliance in various steps critical for ensuring food safety such as improper use of thermometers, lack of documenting processes, and poor employee hygiene. The current study also identified influential factors (operation size, cuisine, and operation type) on leafy green handling and general food safety practices using a scoring system, suggesting practical implications to retail and food service managers.

4.1. Fresh and fresh-cut leafy green produce handling practices

The present study showed that approximately a half of establishments did not properly use the thermometers upon receiving fresh and fresh-cut leafy green produce from their vendors. This is a concern considering the criticality of maintaining the temperatures to ensure the safety of fresh cut leafy green produce (41°F(5°C)) limit according to the U.S. Food and Drug Administration (FDA) Food Code (2013). The result was consistent with findings of Coleman, Delea, Everstine, Reimann, and Ripley (2013) who noted that more than fifty percent of shipments in receiving areas upon delivering leafy green produce were at the temperature of 42 °F or higher. The authors also found that the receiving practices for leafy greens were not consistent among employees. Thus, it is important to develop checklists and standard procedures for proper and consistent receiving practices including temperature assurance for fresh and fresh-cut leafy green produce in retail and food service operations.

Multiple incidents of noncompliance in documentation process were found when receiving fresh and fresh-cut leafy green produce, sanitizing equipment, and ware washing processes. Specifically, most employees did not record the refrigerated temperature every four hours nor did they document the temperature of fresh and fresh-cut leafy green produce upon arrival of a vendor's truck. The improper

documentation of employees has been discussed in previous research (Green & Selman, 2005), supporting the argument that time pressure, high volume of business (or a large number of orders), and inadequate staffing lead to improper documentation practices. Furthermore, Brown et al. (2012) indicated that improper record keeping prevents managers from reviewing historical data to verify that their processes are working properly, suggesting food service operators need to have a designated individual or person-in-charge (PIC) for proper documentation. In addition, managers may consider implementing automatic time and temperature recording device upon arrival and during storage to ensure the freshness and safety of fresh and fresh-cut leafy green produce.

4.2. General food safety practices

Results on general food safety practices revealed poor hand hygiene practices despite the presence of hand washing stations, emphasizing the need for a hand hygiene training system. The fact that all observed establishments were equipped with hand washing stations (e.g. accessible sinks, availability of soap and paper towels) is encouraging, because previous studies have shown that the presence of resources supportive of food safety has a positive impact on safe food preparation (Green & Selman, 2005). Having proper hand washing facilities, however, is not sufficient alone to lead to proper hand-washing practices for employees because hands often come into contact with face, garbage, phones, aprons, equipment, etc., all of which can be considered as potential sources of cross contamination (Henroid, Mendonca, & Sneed, 2004; Roberts et al., 2008). Thus, retail and food service establishments should strive to provide a clear and consistent message regarding the importance of hand washing and should encourage employees to wash their hands and/or change their gloves after touching items that may be contaminated. Ungku Fatimah, Strohbehn and Arendt (2014) also suggested emphasizing potential negative consequences of hand contamination, noting that employees are more likely to engage in safe practices when they are aware of the possible negative consequences if they do not.

The observational results also revealed that poor ware washing practices is one of the factors contributing to crosscontamination events, which may put RTE foods at risk to various hazards in retail and foodservice establishments. Specifically, since contamination of RTE foods (e.g. fresh cut produce) with harmful microorganisms can occur at all stages (e.g. production, processing, transportation, storage, preparation, and service), food contact surfaces referred to any surface that may come in direct contact with fresh and fresh-cut leafy green produce should be washed, rinsed, and sanitized regularly to prevent cross contamination (Sneed & Strohbehn, 2005). Similar findings were reported in other studies where contaminated equipment was identified as one of the risk factors along with the highest non-compliance rates in the FDA Report of the Occurrence of Foodborne Illness Risk Factors (FDA, 2009). In addition, the findings from this current study were consistent with those of Roberts and Sneed (2003) who asserted that around half of their respondents did not have specifications for cleaning and sanitizing equipment. Therefore, it is essential for retail and food service establishments to place a high priority on training employees in terms of proper ware washing processes.

4.3 Factors influencing leafy green handling practices and general food safety practices

Employees's fresh and fresh-cut leafy green produce handling practices were found to vary depending on the establishments' type of cuisine, revealing relatively lower food safety practice scores of ethnic establishments compared to that of non-ethnic establishments using our scoring system. Researchers (Choi, Liu, Lee, & Kwon, 2011; Harris, Dipietro, Murphy, & Rivera, 2014; Liu & Kwon, 2011) have identified several barriers to food safety practices in ethnic foodservice establishments including; language barriers, differences in culture, failure to understand expectations of government regulations and health inspections. The result is consistent with a study (Kwon, Roberts, Shanklin, Liu, & Yen, 2010) noting that independently operated ethnic establishments are of greater concern with regard to health and safety regulations. Thus, the present study suggests that local health departments may consider developing customized training materials for ethnic establishments, both to ensure food safety and to help them meet standards set by government regulations.

In addition to the type of cuisine, some categorical leafy green produce handling practices were also found to vary depending on operation size. While a number of previous studies (Yapp & Fairman, 2006) found that factors such as time and money are more likely to lead to non-compliance with food safety practices in small and medium establishments (SMEs) than large establishments, our results show that small operations showed better leafy green handling practices. Our results are consistent with the findings of Buchholz, Run, Kool, Fielding, and Mascola (2002) noting that medium and large size restaurants were 2.8 and 4.6 times more likely to be involved in foodborne disease incidents compared to small restaurants, respectively. In addition, our data collection was conducted in college towns where the labour pool consisted of students with potentially limited work experience and high turnover. As noted by Youn and Sneed (2003), large establishments consist of a number of hourly employees such as students who do not have food safety certification, and/or have less foodservice experience, and employees without food safety certification or foodservice experience may be less confident and knowledgeable about handling foods safely than employees that have food safety certification. This may explain why the small establishments showed higher leafy green handling practice scores than large establishments.

General food safety practices varied depending on the type of operation, supporting that restaurants showed lower food safety practice scores compared to that of grocery stores, which is consistent with the previous research conducted by Phillips, Elledge, Basara, Lynch, and Boatright (2006). They found that restaurants were more likely than the other foodservice types (e.g. food processors, grocery stores, and super markets) to have recurrent violations of critical items related to food handling. Better food production scheduling and control of grocery stores than that of restaurants may be attributable to better food safety practices. While restaurants may prepare complicated menu items within a limited time (as soon as customers' order is received), grocery stores may schedule food production far in advance under relatively less stressful conditions such as time restraints according to anecdotal evidence from observations. Therefore, there is a need for developing customized training materials depending on the type of operations considering unique challenges of various establishments.

4.4. Limitations and recommendations for future research

This study is not without limitations. First, one of limitations of this current study is no consideration about the final destination of leafy green produce such as cooked or raw dishes. Second, each observation was conducted for a limited amount of time on a single day. Multiple visits or longitudinal observations may increase the generalizability of the results. Third, while the current study only considered employees' number (>10) as a determinant of business size, several other factors including relative menu size and number of covers/volume of business can be considered to identify business size for the future study. Fourth, the data collection was conducted at commercial restaurants and grocery stores. Because organizational culture plays a role in motivating employees' safe food handling (Ungku Fatimah & Arendt, 2013), it would be valuable to examine employees' fresh and fresh-cut leafy green produce handling practices in non-commercial foodservice establishments such as K-12 schools, assisted living facilities, hospitals to develop fresh and fresh-cut leafy green produce training materials. Lastly, while our study only examined operation size, type, and cuisines as influencing factors, future research can consider a variety of factors such as nature of menu, age, gender, food safety knowledge, attitudes, and beliefs affecting fresh and fresh-cut leafy green produce handling practices in retail and food service establishment.

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TABLES AND FIGURES

Table 1
Food establishments' characteristics

Variable		%
Types of fresh and fresh-cut leafy green produce	Heads of lettuce	61
	Only precut leafy greens	12
	Both heads and precut leafy greens	27
Presence of SOP for handling and cleaning of fresh and fresh-cut leafy green produce	Yes	76
	No	18
	No, we plan to in the near future.	6

Table 2
Evaluation of food handlers' leafy green produce handling

Fresh and fresh-cut produce observation	Yes (%)	No (%)	N/A (%)
Receiving			
Calibrated thermometer	58.0	35.5	6.5
Product temperature	77.4	12.9	9.7
Tools for Labeling	77.4	19.4	3.2
Order forms	87.1	9.7	3.2
Temperature log	45.2	45.2	9.7
Products moved to storage	80.6	16.1	3.2
Storage			
Internal thermometer hung in the warmest part of the cooler.	93.5	6.5	
Cooler is at a temperature of 41 or below.	90.3	9.7	
Produce should be stored in a separate cooler.	80.6	16.1	3.2
All items in cooler is labeled, dated and rotated.	76.7	20.0	3.3
All ready to eat is stored on top shelves.	80.6	16.1	3.2
Cooler is clean and items are stored at least at 6" off the floor.	90.3	9.7	
Production Steps (Pre-prepping)			
Produce is not taken out of storage before required.	77.4	22.6	
Produce is washed in clean and sanitized prep sink before use.	83.9	6.5	9.7
Prep tables and all utensils are properly cleaned and sanitized before use.	83.9	12.9	3.2
Employees properly wash hands prior to starting preparation or putting on gloves.	58.1	38.7	3.2

Employees are properly handling RTE foods, using utensils or wearing gloves.	58.1	38.7	3.2
Produce is being properly stored again in cooler after preparation.	86.7	6.7	6.7
Produce is properly date marked after preparation.	93.5	3.2	3.2
Product use			
Labels are checked prior to use to make sure product is still within date limits.	83.9	9.7	6.5
After produce is used in final product, the packaged is re-labeled with proper date.	80.6	12.9	6.5
Produce is kept within proper temperature during entire process.	87.1	12.9	
Cool storage			
Temperature of display unit is in proper temperature.	83.9	6.5	9.7
Products are properly dated, labeled and rotated when placed in display unit.	87.1	3.2	9.7
Labels are checked to pull out-of-date products.	83.9	6.5	9.7
Display for consumer use			
Units are properly cleaned and sanitized.	83.9	3.2	12.9
Units are at proper temperature.	74.2	9.7	16.1
Products are properly rotated when placed in consumer area.	83.9		16.1
Water being sprayed is properly cleaned and sanitized.	71.0	9.7	19.4
Cold bar			
Bar is properly cooled prior to produce being placed on the bar.	64.5	32.3	3.2
Produce is properly rotated when placed on cold bar.	64.5	32.3	3.2
Utensils are properly used for produce.	61.3	35.5	3.2
Produce is properly stored at the end of the day to be reused for the next day.	64.5	32.3	3.2
Employee			
Check for washing hands, wearing clean clothing, wearing a hair restraint.	71.0	25.8	3.2
Check if one or more person is in charge of checking temperature and recording on a monitoring log.	53.6	25.0	21.4

514

515 **Table 3**516 **Evaluation of food handlers' general food safety assessment**

Food Safety Assessment Form (%)	1(Yes)	2(No)	3(N/A)
Food temperature/Time control/Preparation			
Temperatures are taken every _4 hours.	51.6	45.2	3.2
Hot foods held above 135°F.	71.0	9.7	19.4
Calibrated thermometers are used to check temperatures.	58.1	41.9	
Temperatures of food are checked and recorded prior to placing on food bar.	54.8	29.0	16.1
Cold foods held at 41°F or below.	93.5	6.5	
Staff demonstrates knowledge or proper temperatures for foods/food safety knowledge.	80.6	19.4	
Personnel			
Employees with infections restricted/excluded.	83.9	3.2	12.9
Proper personal hygiene practices observed.	71.0	29.0	
Employees observed with hair restraints and clean uniforms.	74.2	25.8	
Employees observed washing hands.	45.2	41.9	12.9
Food handling/ Source			
Foods are properly labeled, dated, and rotated.	93.5	6.5	
Use gloves/utensils as needed.	80.6	19.4	
Flow of food appropriate.	90.3	6.5	3.2
Food Preparation			
Work space, equipment, cutting boards sanitized when needed.	90.3	9.7	
Recipes being used.	83.9		16.1
Employees following establishment practices.	90.3	9.7	
SOP's being followed.	64.5	35.5	
Food placed in sanitized containers.	83.9	16.1	

Food being properly chilled/refrigerated.	96.8	3.2	
Facility			
Hand washing sink is located in food prep area with proper drying and is accessible.	96.8	3.2	
Hand washing facilities are properly stocked with paper towels, soap, nail brush, and trash can.	100.0		
Food contact surfaces cleaned and maintained.	96.8	3.2	
Non-food contact surfaces clean and maintained.	80.6	19.4	
Lighting adequate.	80.6	19.4	
Serving utensils are available, cleaned, and sanitized.	87.1	12.9	
Chemicals are stored away from food and properly labeled.	90.3	9.7	
Service/food bar			
Containers are changed and refilled properly.	54.8		45.2
Food bars have proper utensils/long handled spoons, tongs.	51.6	6.5	41.9
All food items/utensils are properly labeled.	58.1	6.5	35.5
Surfaces are cleaned/sanitized and wiped regularly.	64.5		35.5
Sneeze guards present on bar as appropriate/kept clean.	51.6		48.4
Temperatures of food are taken on a regular basis/use thermocouple in center of food.	38.7	16.1	45.2
Bar is set-up to avoid cross contamination.	54.8	3.2	41.9
Storage			
Refrigeration: temperatures are checked at least daily.	83.9	16.1	
Refrigeration temperatures are documented with corrective action as appropriate.	58.1	38.7	3.2
Freezers: temperatures are checked at least daily.	80.6	19.4	
Freezer temperatures are documented with corrective action as appropriate.	58.1	38.7	3.2
Raw and cooked foods are stored separately.	74.2	16.1	9.7
Food stored in proper containers.	93.5	6.5	
Dry storage temperatures are between 50°F and 70°F.	56.7	30.0	13.3
Food is stored at least 6" above floor throughout the facility.	87.1	12.9	
Ware washing			
Manual washing ppm/temperature documented.	12.9	71.0	16.1
Mechanical washing ppm/temperature documented.	16.1	74.2	9.7
Adequate ware washing facilities.	90.3	6.5	3.2

Table 4

T-test results of overall fresh and fresh-cut produce handling scores

		N	Mean	Std. Deviation	t-test for Equality of Means		
					t	df	Sig. (2-tailed)
Operation size	≤10	12	18.91	15.98	2.134	13.4	0.050
	>10	17	8.52	6.38			
Cuisine	Ethnic	21	8.42	7.33	-2.485	11	0.030*
	Non-ethnic	10	21.10	15.30			
Operation type	Grocery store	15	13.73	13.75	0.543	29	0.591
	Restaurant	16	11.37	10.27			

^a * < .05, ** < .01, *** < .001

*Note: Homogeneity of variance assumption suggested by Keppel and Wickens (2004) was satisfied for the group comparison between ethnic and non-ethnic operations.

Table 5

T-test results of categorical fresh and fresh-cut produce handling scores

	# of employees	N	Mean	S.D.	t-test for Equality of Means
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						t	df	Sig. (2-tailed)
Operation size	Receiving	≤10	12	4.42	3.94	1.547	27	0.134
		>10	17	2.41	3.04			
	Storage	≤10	12	2.83	2.44	2.227	27	0.034*
		>10	17	1.06	1.85			
	Production step	≤10	12	2.67	3.37	-0.136	27	0.893
		>10	17	2.82	2.81			
	Product use	≤10	12	1.17	1.99	0.705	27	0.487
		>10	17	0.71	1.53			
	Cool storage	≤10	12	1.33	1.92	1.986	13.243	0.068
		>10	17	0.18	0.73			
	Display for consumer use	≤10	12	2.00	2.13	2.272	15.338	0.038*
		>10	17	0.47	1.12			
	Cold bar	≤10	12	2.33	2.06	2.051	27	0.050
		>10	17	0.06	3.42			
Employee	≤10	12	2.17	1.70	2.471	27	0.020*	
	>10	17	0.82	1.24				
						t-test for Equality of Means		
						t	df	Sig. (2-tailed)
Cuisine	Receiving	Ethnic	21	2.33	3.50	-2.032	29	0.050
		Non ethnic	10	4.90	2.77			
	Storage	Ethnic	21	0.95	1.63	-2.497	12.431	0.027*
		Non ethnic	10	3.20	2.62			
	Production step	Ethnic	21	2.38	2.31	-1.155	11.761	0.271
		Non ethnic	10	4.00	4.14			
	Product use	Ethnic	21	0.52	1.40	-1.552	29	0.132
		Non ethnic	10	1.50	2.07			
	Cool storage	Ethnic	21	0.24	0.77	-2.298	29	0.029*
		Non ethnic	10	1.40	2.07			
	Display for consumer use	Ethnic	21	0.43	1.03	-2.996	11.173	0.012*
		Non ethnic	10	2.50	2.07			
	Cold bar	Ethnic	21	0.76	1.51	-0.334	9.797	0.746
		Non ethnic	10	1.30	4.99			
	Employee	Ethnic	21	0.81	1.29	-2.759	29	0.010*
		Non ethnic	10	2.30	1.64			
						t-test for Equality of Means		
						t	df	Sig. (2-tailed)
	Receiving	Grocery store	15	3.40	4.40	0.360	21.227	0.722
		Restaurant	16	2.94	2.38			
	Storage	Grocery store	15	1.93	2.43	0.613	29	0.545
		Restaurant	16	1.44	2.06			
	Production step	Grocery store	15	3.93	3.53	1.899	29	0.067
		Restaurant	16	1.94	2.21			
	Product use	Grocery store	15	1.13	2.10	0.946	29	0.352
		Restaurant	16	1.13	2.10			

Operation type	Cool storage	Restaurant	16	0.56	1.15	0.455	29	0.652
		Grocery store	15	0.73	1.71			
	Display for consumer use	Restaurant	16	0.50	1.10	-0.093	29	0.927
		Grocery store	15	1.07	1.83			
	Cold bar	Restaurant	16	1.13	1.67	-1.464	29	0.154
		Grocery store	15	0.13	3.72			
	Employee	Restaurant	16	1.69	1.99	0.375	29	0.710
		Grocery store	15	1.40	1.59			
		Restaurant	16	1.19	1.56			

^a * < .05, ** < .01, *** < .001

Table 6

T-test results of overall scores on food safety practices

		N	Mean	Std. Deviation	t-test for Equality of Means		
					t	df	Sig. (2-tailed)
Operation size	≤10	12	21.42	12.52	-0.356	27	0.724
	>10	17	23.47	16.93			
Cuisine	Ethnic	21	20.86	15.48	-0.508	29	0.615
	Non ethnic	10	23.80	14.13			
Operation type	Grocery store	15	30.13	15.33	3.499	23.023	0.002**
	Restaurant	16	14.00	9.45			

^a * < .05, ** < .01, *** < .001

Table 7

T-test results of categorical scores on food safety practices

T-test results of categorical scores on food safety practices								
		# of employees	N	Mean	S.D.	t-test for Equality of Means		
						t	df	Sig. (2-tailed)
Operation size	Temperature	≤10	12	4.42	2.84	-0.839	27	0.409
		>10	17	5.35	3.04			
	Personnel	≤10	12	1.92	2.02	-0.789	27	0.437
		>10	17	2.65	2.71			
	Food handling	≤10	12	0.50	1.24	-0.725	27	0.474
		>10	17	0.88	1.50			
	Food preparation	≤10	12	2.00	1.54	0.531	27	0.600
		>10	17	1.59	2.35			
	Facility	≤10	12	1.33	2.10	0.052	27	0.959
		>10	17	1.29	1.90			
	Food bar	≤10	12	3.50	3.48	-0.365	27	0.718
		>10	17	3.94	3.01			
	Storage	≤10	12	4.08	3.09	-0.064	27	0.949
		>10	17	4.18	4.29			
	Ware washing	≤10	12	5.50	1.93	0.775	27	0.445
		>10	17	4.88	2.23			
		Cuisine	N	Mean	S.D.	t-test for Equality of Means		
						t	df	Sig. (2-tailed)

Cuisine	Temperature	Ethnic	21	5.38	2.85	1.369	29	0.181
		Non ethnic	10	3.90	2.73			
	Personnel	Ethnic	21	2.38	2.31	0.408	29	0.686
		Non ethnic	10	2.00	2.67			
	Food handling	Ethnic	21	0.43	1.12	-1.315	12.929	0.211
		Non ethnic	10	1.20	1.69			
	Food preparation	Ethnic	21	1.10	1.37	-2.373	29	0.025*
		Non ethnic	10	2.80	2.66			
	Facility	Ethnic	21	1.10	1.81	-0.545	29	0.590
		Non ethnic	10	1.50	2.17			
	Food bar	Ethnic	21	3.29	3.20	-0.753	29	0.458
		Non ethnic	10	4.20	3.08			
	Storage	Ethnic	21	3.57	4.15	-0.631	29	0.533
		Non ethnic	10	4.50	2.99			
	Ware washing	Ethnic	21	5.24	2.14	0.424	29	0.674
		Non ethnic	10	4.90	1.91			
Operation type	Temperature	Type	N	Mean	S.D.	t-test for Equality of Means		
						t	df	Sig. (2-tailed)
	Temperature	Grocery store	15	6.47	2.72	3.444	29	0.002**
		Restaurant	16	3.44	2.16			
	Personnel	Grocery store	15	3.80	2.37	4.334	21.206	0.000***
		Restaurant	16	0.81	1.28			
	Food handling	Grocery store	15	1.40	1.68	3.224	14.000	0.006**
		Restaurant	16	0.00	0.00			
	Food preparation	Grocery store	15	2.40	2.47	2.143	29	0.041*
		Restaurant	16	0.94	1.12			
	Facility	Grocery store	15	1.80	2.43	1.631	19.055	0.119
		Restaurant	16	0.69	1.08			
	Food bar	Grocery store	15	4.07	3.37	0.830	29	0.413
		Restaurant	16	3.13	2.94			
	Storage	Grocery store	15	5.47	4.31	2.411	22.465	0.025*
		Restaurant	16	2.38	2.55			
	Ware washing	Grocery store	15	5.67	1.84	1.442	29	0.160
		Restaurant	16	4.63	2.16			

^a *.05, **.01, *** < .001

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