



Microbiological quality of ready-to-eat fresh vegetables and their link to food safety environment and handling practices in restaurants



Dima Faour-Klingbeil ^{a,*}, Ewen C.D. Todd ^{b,c}, Victor Kuri ^a

^a School of Biological Sciences, Plymouth University, UK

^b Department of Nutrition and Food Science, American University of Beirut, Lebanon

^c Ewen Todd Consulting, Okemos, MI, USA

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ABSTRACT

The increased consumption of ready-to-eat salads outside homes as a result of a fast paced lifestyle, awareness on their nutritional attributes and enhanced processing technology is well documented. This study aimed to determine the microbiological quality of fresh-cut salads vegetables in small and medium sized foodservice establishments (SMEs) and to identify risk factors and handling practices through observational assessment in order to investigate if an association between microbiological quality and visual assessment (inspection) scores can be established.

A total of 118 samples fresh-cut vegetable salads were collected from 50 inspected locations and analysed microbiologically, in addition to 49 swabs of knives and cutting boards. There was no statistically significant correlation between visual assessment scores and bacteriological counts on vegetables or cutting boards. Nonetheless, the consistent relationship between inspection ratings on cross-contamination and cleaning components and *Listeria* spp. levels was statistically significant. This study demonstrated that overall visual assessment scores would not directly reflect the safety of salad vegetables and that the significance of microbiological assessment should be considered in relation to individual inspection components. It is necessary to place effective control measures on cleaning standards and risk of cross-contamination to improve the microbiological safety of fresh salad vegetables in SMEs.

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1. Introduction

Fresh vegetables are rich sources of water-soluble vitamins and other nutrients essentials to improve the nutritional status and decrease the risk of cardiovascular disease (Su & Arab, 2006). However, when they are not carefully prepared, they can be subjected to pathogenic contamination and become hazardous to health particularly when eaten raw (WHO, 2008).

Outbreak investigations often indicate that food service establishments (FSE) greatly contribute to foodborne illnesses involving fresh produce (Jones & Angulo, 2006; Sodha et al., 2011). Multiple studies revealed that food workers were frequently engaged in unsafe food handling (Clayton & Griffith, 2004; Manning, 1994; Rajagopal & Strohbehn, 2013; Sneed, Strohbehn, & Gilmore, 2004) and that microbial contamination of ready-to-eat (RTE) foods typically occurred in FSEs with food handlers as

asymptomatic carriers of pathogenic microorganisms or with poor personal hygiene being involved (McEvoy, Sheridan, Blair, & McDowell, 2004; Todd, Greig, Bartleson, & Michaels, 2008). Equipment or surfaces that have not been effectively cleaned or remained wet between cleaning and use also serve as direct routes for contamination of ready to eat foods (Evans, Russell, James, & Corry, 2004; Gill, Bryant, & Badoni, 2001), besides inappropriate storage temperatures, and insufficient cooking (Jones, Parry, O'Brien, & Palmer, 2008; WHO., 2007).

Less information is available on the relative health risks attributed to handling practices and preparation procedures of raw salad vegetables in SMEs, while other RTE foods and meats have attracted more attention.

Inspection tools are essential for capturing information on the general hygiene standards and food handlers' practices. Although private or local authorities' inspections are an effective mechanism to assure compliance to food safety standards, there is no a clear indication of a correlation between risk of foodborne illnesses and inspection scores. There have been many cases when restaurants scored high on inspections and were still having critical violation in

* Corresponding author.

E-mail address: dima.faour@gmail.com (D. Faour-Klingbeil).

food safety (Jones, Pavlin, LaFleur, Ingram, & Schaffner, 2004). The significance of association of microbiological quality of RTE vegetables to hygiene inspection scores has not been fully investigated and not sufficiently addressed by researchers. Earlier attempts to establish direct relationship between the results on microbiological analysis of food and visual inspections have not been successful and were mostly based on foods of animal origins (Powell & Attwell, 1995; Tebbutt & Southwell, 1989; Wyatt & Guy, 1980).

This study aimed at conducting observational assessment of the fresh produce handling processes from the receiving stage until display and service to identify risk factors that may be associated with the microbial safety of fresh produce in SMEs which will provide further insights to devise effective preventive measures.

2. Material and methods

2.1. Observational survey

A convenience sample of fifty SMEs located in Beirut were observationally assessed for hygiene standards and handling practices of food handlers during the salad vegetable preparation. The survey checklist comprised 6 constructs of 2–7 components for analysis in which the good hygienic practices (GHP) and other prerequisites proposed by the Codex Alimentarius (CAC/RCP 1, 1969) were considered for the visual assessment (Table 1). Additional components in relation to salad preparation practices were also included. The criteria for each component were defined to specify limits for classification. (Supplementary materials).

A reliability analysis test was performed to measure the internal consistency in the survey questionnaire. Cronbach's Alpha was 0.928 which indicates a high level of internal consistency for our scale.

2.2. Additional information

Additional 8 questions on handling practices of fresh vegetables

during receiving, washing and storage were posed to food handlers ($n = 80$) via face-to-face interviews that were conducted in our earlier study on food safety knowledge, attitudes and practices (Faour-Klingbeil, Kuri, & Todd, 2015). The questions were ranked on a five points rating scale (never = 1, rarely = 2, sometime = 3, often = 4 and always = 5).

To ensure consistency and unbiased data records, the data collection and visual assessment were carried out by one of the authors (Dima Faour-Klingbeil - Registered professional food auditor).

2.3. Collection of RTE fresh-cut salads vegetables samples

2.3.1. Management of samples

A total of 118 samples of various fresh cut RTE salad vegetables (lettuce, parsley, arugula, coriander, cucumber, tomato and radish) prepared in 50 restaurants were collected after washing and cutting/chopping. On average, 3 types of vegetables were sampled from each restaurant, being subjected to availability and preparation plans at times of visits. They were placed in a sterile bag by food handlers at the end of the preparation process by means of utensils or tools typically used when bringing them into display or storage containers, taking care that they would not touch the inside of the bags.

2.3.2. Swabs of cutting boards and knives

Before cutting/chopping vegetables, surfaces of cleaned cutting boards and knives (normally cleaned by assigned cleaners in well-established restaurants, or food workers in less developed restaurants) were swabbed by moistened cotton-tip in buffered peptone water (BPW) (Bio-rad laboratories Ltd, Hemel Hempstead, UK) in three different directions: left to right, top to bottom, and diagonal over a 50 cm² area for cutting boards and a length of ca. 10 cm on knives. The swabs were placed in tubes of 5 ml buffered peptone water for subsequent analysis.

Table 1

The six different constructs comprised in the visual assessment survey in SMEs.

Inspection constructs	Individual inspection components
Construct 1: Structural compliance	<ul style="list-style-type: none"> • General maintenance conditions and evidence of pest in the production environment • Zoning (separation of fresh produce from raw meat and poultry) • All major pieces of equipment such fridges, freezers ovens, hot holding equipment, cold holding equipment are fitted with working temperature monitoring gauges • Availability of proper handwashing sink
Construct 2: Personal hygiene	<ul style="list-style-type: none"> • Wearing hair cap • Appropriately clean personnel protective clothing
Construct 3: Sanitation	<ul style="list-style-type: none"> • Clean floors, walls, overall facilities and implements • Waste containers are covered, kept clean • Sanitisers for work surfaces readily available for use during food preparation • Containers used to drain vegetables are kept clean
Construct 4: Evidence of procedures and management system control	<ul style="list-style-type: none"> • Records keeping for verification of temperature monitoring and system audits (during cooking, cooling, storing) • Cleaning system and schedule • Where a chemical sanitiser is used, there are records to show levels are maintained
Construct 5: Contamination and cross contamination control measures	<ul style="list-style-type: none"> • Staff cleaning tools are stored in appropriate manner and not at risk of contaminating food or equipment during preparation • Staff personal belongings are stored in appropriate manner and not at risk of contaminating food or equipment during preparation? • Received fresh vegetable are stored in protected areas • Washing sink designated for fresh produce only • Unprocessed raw vegetables are prepared so that contamination and cross- contamination does not occur (separate cutting boards and utensils) • Visitors or unauthorized staff are granted protective clothing upon entry • Entry for authorized personnel only
Construct 6: Safe and hygienic handling practices	<ul style="list-style-type: none"> • Appropriate use of gloves and handwashing • Frozen food is properly thawed • Vegetable sanitizers are made up correctly • Food on hold is covered

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