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# Observations of Consumer Salad Preparation

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## ABSTRACT

Video footage of 199 volunteers in Northern California as they prepared salad was analyzed for adherence to safe handling recommendations as recommended by the FightBAC! Food Safety Educational Campaign. Almost half of the participants washed lettuce under running water with hand rubbing as recommended, with 15% not washing lettuce at all. Higher percentages of volunteers used hand rubbing and running water on tomatoes (67%) and celery (74%). The majority of volunteers shook the water off of their lettuce (58%), tomatoes (75%) and celery (81%) to dry them. Only 27% of volunteers removed stem scars from tomatoes even though studies have shown that higher numbers of bacteria may be found in tomato stem scars compared to the other parts of tomatoes. Video analysis has shown that consumer preparation of produce used in salad may not be adequate.

## INTRODUCTION

Foodborne illness imposes a significant health and economic burden on the population of the United States. The Centers for Disease Control and Prevention estimates that 31 major pathogens cause 9.4 million episodes of foodborne illness, 55,961 hospitalizations and 1,351 deaths each year *(20)*. The financial impact of foodborne illness can reach billions of dollars every year *(21)*. One foodborne pathogen, *E. coli* O157, acquired from domestic sources is estimated to sicken 63,000 people a year *(20)*. The annual cost in 2003 associated with *E. coli* O157:H7 was estimated to be $450 million in the United States *(8)*. Outbreaks have been linked to produce including fresh-cut leafy greens *(1, 5, 9, 12)*. For example, in 2006 an *E. coli* O157:H7 outbreak that sickened over 200 people was linked to fresh spinach, possibly contaminated by wild pigs found in the vicinity of the implicated farms *(5)*.

Large outbreaks of foodborne illnesses are generally well-publicized, a fact that is reflected by changes in the purchasing patterns of consumers. The Food Marketing Institute annual report on consumer shopping showed that buying decisions are affected by highly publicized food recalls *(7)*. In 2009, 60% of consumers reported that they stopped buying items containing peanuts after the Peanut Corporation of America recall while in 2007, 74% reported that they stopped buying spinach. Purchase of bagged salads, lettuce, and tomatoes have also been affected by foodborne illness outbreaks.

Recommendations for produce preparation include hand washing before handling produce, washing equipment with hot soapy water, using running water to wash leafy vegetables, drying fresh produce with clean paper towels or a clean salad spinner and scrubbing firm-skinned produce with a clean vegetable brush under running water *(16, 18)*. About 80% of participants in a nationwide survey indicated that they washed fresh produce before further preparation while 6% of participants reported that they "seldom or never wash" fresh produce *(15)*. Direct video observation of produce washing shows that compliance with recommended washing practices may not be as high as suggested by surveys. When volunteers were filmed during meal preparation, only 60 to 71% were observed washing lettuce during meal preparation *(2, 22)*.

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**TABLE 1. Demographic data for volunteers compared to 2008 demographic data for the state of California (n = 199)**

| | Volunteers | California |
|---|---|---|
| **Ethnicity** | **%:** | **%:** |
| Caucasian, not Hispanic | 58 | 42 |
| Asian | 14 | 13 |
| Hispanic | 14 | 37[1] |
| African American | 13 | 7 |
| Native American | 1 | 1 |
| **Highest level of education** | **%:** | **%:** |
| College graduate | 56 | 27 |
| Some college | 35 | |
| High school diploma | 8 | 50 |
| Some high school | 1 | |
| **Age of household members** | **%:** | |
| <5 old | 26 | |
| 5–12 years old | 35 | |
| 13–18 years old | 35 | |
| 19–29 years old | 44 | |
| 30–39 years old | 37 | |
| 40–49 years old | 37 | |
| 50–59 years old | 17 | |
| 60–69 years old | 6 | |
| 70 years or older | 3 | |

[1]From the United States Census Bureau data: "Hispanics may be of any race, so are included in applicable race categories."

In addition to proper washing, removing potentially contaminated sections of produce may reduce the risk of foodborne illness. Tomato stem scars are more likely to contain pathogens than other interior areas of the tomato *(10, 11, 25)*. Guo and colleagues *(11)* demonstrated that *Salmonella* from moist inoculated soil is brought into the tomato fruit through the stem scar. Zhuang et al. *(25)* found that a 60-ppm chlorine solution was less effective in destroying *Salmonella* Montevideo in the stem scar tissues than in exterior cells. This suggests that it would be prudent to remove and discard the stem scar section of a tomato.

While people may be aware of safe handling recommendations, they do not always follow them. Direct observation and video recordings can be used to analyze actual food-handling behavior and provide insight as to which behaviors are routinely followed, and which are seldom or never practiced. This information can guide food safety educators as to what food handing behaviors should receive greater emphasis. Video camera footage provides compelling visual evidence that consumers are not following food safety guidelines while preparing food, and are therefore exposing themselves to possible foodborne illness *(2, 13, 22)*. The purpose of this study is to identify practices that could put consumers at risk for foodborne illness while preparing salad in their homes.

## METHODS AND MATERIALS

Volunteers were invited to demonstrate how they prepared burgers and a salad in their home. In appreciation for allowing university researchers to observe their food preparation practices, volunteers were provided ingredients for the burgers and salad and a gift card valued at $50. The study was advertised in local newspapers and by word of mouth, posting on community and library bulletin boards and the Internet, and featured on a local television news program. The advertisement invited people who eat burgers to "show us how you cook them." Study protocol was approved by the Institutional Review Board at the University of California.

Volunteers responded to the advertisement by contacting the authors via telephone. To meet Institutional Review Board requirements, volunteers were required to be at least 18 years old. Each volunteer was asked screening questions to affirm that they ate beef burgers, spoke English and did not have specialized food safety knowledge. People trained as microbiologists, nurses, physicians or dieticians were excluded from the study. The volunteers were informed that they would be videotaped, and would be briefed about informed consent prior to filming.

Frozen burger patties, buns, iceberg or leaf lettuce (not prewashed), celery and tomatoes were purchased in a local supermarket and delivered to the home of the volunteer at least two days before filming of the food preparation. On the day of the filming, two research assistants advised the volunteers of their rights, reviewed study procedures, and obtained a sign consent form. The consent form noted that researchers would record the temperature of the burger when the volunteer finished cooking. Food safety and washing techniques were not mentioned. A video camera was deployed in the food preparation areas of the volunteer's home to capture footage of hand washing, vegetable preparation and cooking. A second camera was deployed, if needed, to ensure that all food preparation actions were recorded. A live video feed was en-

**TABLE 2. Consumer washing and drying methods for lettuce**

| Lettuce washing (n = 179) | Percentage |
|---|---|
| Did not wash | 15 |
| Washed | 85 |
| **Separation of lettuce leaves** | **Percentage** |
| Washed each leaf separately | 40 |
| Washed whole head under running water | 28 |
| Separated leaves but washed as a whole | 20 |
| Soaked | 12 |
| **Washing technique** | **Percentage** |
| Water and hand rubbing | 47 |
| Water only | 36 |
| Commercial sanitizer | 2 |
| Did not wash | 15 |
| **Lettuce drying method (n = 153)** | **Percentage** |
| Shake water off | 58 |
| Salad spinner | 18 |
| Paper towel | 16 |
| Cloth | 3 |
| Did not dry | 5 |

abled through the use of a Pinnacle video capture device linked to a laptop, so that the research assistants could remotely view the actions of the volunteer from another room where possible. This was done to reduce observational bias while footage was being captured. The volunteer was then asked to prepare the vegetables and the burgers following their normal food preparation methods and to inform the research assistants when the cooking was deemed to be complete.

After preparation of the burgers and the salad was complete, the volunteer ate the meal while survey personnel packed the video equipment. When the volunteer finished eating, a 23-question survey on food safety knowledge and handling practices was verbally administered to the volunteer and the responses recorded on the survey instrument. Finally, volunteers were given a $50 gift card, a food thermometer and a refrigerator thermometer. Informational flyers containing food safety recommendations on cooking ground beef ("Now You're Cooking… Using A Food Thermometer!") *(23)*, washing produce ("Safe-Handling of Fruit and Vegetables) *(4)* and food irradiation ("Frequently Asked Questions About Food Irradiation") *(3)* were also handed out.

The video footage was evaluated for behaviors relevant to food safety, including produce preparation methods. Four students were trained to complete a behavior score sheet which included produce washing methods, washing times and drying methods. Data entered was validated by a second student. Statistical differences were determined using Student's t-test calculated through Microsoft Excel. This paper summarizes consumer handling of produce. Information related to handling and preparation of meat is reported elsewhere *(19)*.

## RESULTS

A total of 201 volunteers from Northern California (Santa Clara, Alameda, San Francisco, Sacramento, Stockton and Yolo counties) participated in the study. Two questionnaires were lost, leaving a sample size of 199 for demographic analysis. Most participants were Caucasian 58%, with 14% of volunteers identifying themselves as Asian and 13% as African American (Table 1). Compared to the state's population, Hispanics were underrepresented in this study, while Caucasians not Hispanic and African Americans were over-represented *(24)*. A little over half of the volunteers, 56%, indicated that they had at least a college degree with an additional 35% having completed some college education. Less than 10% of the respondents did not attend college. College degree holders are over represented in this study, since 56% of volunteers reported holding a degree while only as 27% of Californians held college degrees in 2008. Households in this study consisted mostly of younger families, with 49% having children 12 years old or younger. Households with older adults were also represented with 26% of families with adults in their 50s or older and 9% of families with adults who were 60 years old or older.

Despite careful positioning of the cameras, in some instances volunteers unintentionally hindered recording of their food preparation practices by blocking the camera's view. Of the 179 volunteers whose lettuce preparation was video recorded, 47%, employed hand rubbing or scrubbing under running water during the wash process (Table 2). A total of 36% washed the lettuce by rinsing under running water without hand rubbing or scrubbing. Some volunteers, 15%, did not wash lettuce before using it. The majority, 40%, of the 153 volunteers who washed lettuce washed each leaf individually. The average wash time for lettuce was 5 s per leaf for volunteers that washed each leaf individually. About 28% of volunteers who washed lettuce washed the entire head under running water without separating the leaves. A fifth of the volunteers took apart the lettuce to some degree but washed the leaves as a whole rather than washing each leaf individually. Only 12% soaked the lettuce leaves by immersing them in a container of water instead of washing them under running water.

The most commonly employed method of drying lettuce was by shaking the water from the leaves. Lettuce was

**TABLE 3. Consumer washing and drying methods for tomatoes and celery**

| Tomato washing method (n = 176) | Percentage |
|---|---|
| Water and hand rubbing | 67 |
| Water only | 18 |
| Commercial sanitizers | 2 |
| Other | 1 |
| Did not wash | 12 |
| **Tomato drying method (n = 138)** | **Percentage** |
| Shake water off | 75 |
| Paper towel | 9 |
| Salad spinner | 3 |
| Cloth | 3 |
| Did not dry | 10 |
| **Celery washing method (n = 140)** | **Percentage** |
| Water and hand rubbing | 74 |
| Water only | 18 |
| Did not wash | 8 |
| **Celery drying method (n = 129)** | **Percentage** |
| Shake water off | 81 |
| Paper towel | 6 |
| Salad spinner | 2 |
| Cloth | 1 |
| Did not dry | 10 |

dried using a salad spinner by 18% of volunteers. Only 16% of volunteers used a clean paper towel to dry lettuce. A total of 5% of volunteers who washed lettuce failed to dry it.

The most commonly employed method for cleaning tomatoes was washing under running water with hand rubbing, practiced by 67% of the volunteers (Table 3). Almost a fifth, 18%, used water only, without hand rubbing. In total, 12% of volunteers who used tomatoes failed to wash them. The average washing time per tomato was 8 s. The majority of volunteers, 75% who dried tomatoes did so by shaking them. Only 9% of tomato drying events involved the use of a clean paper towel. A total of 10% failed to dry their tomatoes. When slicing, 27% of volunteers attempted to remove the stem scar portion of the tomatoes.

Of the 140 volunteers who were recorded preparing celery, 74% percent cleaned the stalks with a combination of running water and scrubbing or hand rubbing (Table 3). Almost a fifth, 18% washed their celery with water without hand rubbing. Less than a tenth, 8%, did not wash their celery. The average washing time for celery was 9 s. The vast majority, 81%, of volunteers dried celery by shaking it. Only 6% dried celery using a clean paper towel. A tenth of the volunteers who washed celery did not dry it.

## DISCUSSION

Volunteers were recruited through advertising rather than by a systematic random sampling method. They have a higher level of formal education than the California population and, although the researchers sought people without training in microbiology, half of the volunteers had received food safety training (reported elsewhere), most commonly from working in a restaurant. Therefore the sample may be considered more knowledgeable as to safe handling practices than the general population.

A high rate of produce washing was observed in this study. According to the FightBAC! Educational Campaign guidelines, produce should be washed under running water. Most volunteers attempted to wash the provided vegetables, with 85% of volunteers washing lettuce, 88% tomatoes and 92% celery. This video analysis is consistent with reported washing rates reported by Li-Cohen and Bruhn *(15)*, in which 80% of respondents said that they would wash produce, and the video study of Anderson et al. *(2)* in which 94% of volunteers rinsed tomatoes while 71% rinsed lettuce. However, fewer volunteers washed lettuce (60%) and tomatoes (73%) according to video observation by Scott and Herbold *(22)*. The average washing time for lettuce in this study, 5 s, is shorter than the 12.3 s observed by Anderson et al. *(2)*.

The methods volunteers used to wash produce varied depending on the type of produce washed. Volunteers elected to wash lettuce by water without hand rubbing nearly half of the time, but the majority of volunteers used hand rubbing on tomato (67%) and celery (74%). We further examined lettuce washing to assess thoroughness. Even though most volunteers attempted to wash lettuce, the majority did not follow recommended guidelines. Less than half washed each lettuce leaf separately, and about a quarter only washed the outer leaves. Thus, many households would have been exposed to higher bacterial counts if the lettuce had been contaminated. A total of 12% soaked the lettuce instead of washing it under running water. Soaking is not recommended as contamination may spread from one area of the lettuce to the entire head. This sample included households with members at increased risk for foodborne illness due to age, that is, children and older adults, so failure to follow recommended practices could have significant consequences.

While volunteers were not asked to explain their choice of vegetable washing methods, the different approaches

may relate to the nature of the vegetables themselves. Lettuce leaves may be considered more delicate than celery stalks. This may explain why some volunteers opted to soak their lettuce instead of using hand rubbing and running water.

Drying has been demonstrated to further reduce the level of bacteria on produce *(17)*. Consumers approached produce drying quite casually, with many simply shaking off excess water. Food safety educators may advise the public to dry produce by using either a clean single use paper towel, freshly laundered cloth towel or salad spinner.

About a quarter of volunteers removed the stem scars from their tomatoes, probably for textural or appearance reasons. Since bacteria may be found in tomato stem scars, cutting and removing stem scars may be a quick and easy way for consumers to increase microbial food safety when eating raw tomatoes *(10, 11, 25)*. We recommend that food safety educators include this step in their food safety recommendations as it is easily implementable but not yet widely practiced.

It should be noted that volunteer food handling practices were recorded in the presence of video cameras and two technicians who were not known personally by the volunteers. While volunteers were encouraged to prepare the food as they normally would, routine cooking situations do not typically include the presence of cameras and research technicians. The technicians were careful in their interactions with volunteers not to sensitize them to the food safety aspects of the study, but the volunteer may have a heightened awareness of his or her food handling practices while being observed and thus may have been more careful than usual during food preparation. Critical violations and deviations from recommended food safety practices reported in this study occurred frequently despite the extra care that the volunteers may have taken as they worked. Food safety violations may occur even more frequently in routine food preparation situations compared to the experimental situation. Observational studies done on nurses suggest that bias caused by the presence of cameras is slight *(6, 14)*.

Detailed information of the method and duration of produce washing can be used in the development of realistic risk assessment models. This study has shown that consumers frequently commit food safety violations during routine meal preparation in the home. Details of the washing process, such as washing under running water, rubbing produce surfaces when appropriate, drying produce, and cutting out the stem in tomatoes, should receive greater emphasis in food safety education messages.

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# In Memory

## *Raymond A. Belknap*
## *Sun City Center, Florida*

We extend our deepest sympathy to the family of Raymond A. Belknap who recently passed away. IAFP will always have sincere gratitude for his contribution to the Association and the profession. Mr. Belknap had been a member of IAFP since 1947 and was President of the Association in 1963.