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Consumption Data and Consumer Handling Practices of Leafy Greens in the City of São Paulo, Brazil: Useful Information for Quantitative Microbiological Consumer Phase Risk Assessments

ABSTRACT

This study surveyed consumers in the city of São Paulo, Brazil, on their consumption and handling practices for leafy greens. A 14-question survey was administered in two large supermarkets in the city. The majority of the 225 participants who responded were female (64%); 42.2% were single and 33.3% were age 31–50 years. Almost all participants (98%) reported eating leafy greens regularly, with an average daily consumption of ~60 g per meal (~60 to 120 g per day). Lettuce, arugula and collard greens were the most frequently cited varieties. The preferred shopping locations were farmers' markets and supermarkets. All consumers reported washing leafy greens prior to consumption, most using tap water only, followed by those who used water with added culinary vinegar and those who used chlorinated water. Pearson's chi-square test results indicated no statistically significant relationship ($P \geq 0.05$) between the demographic characteristics of participants and their consumption behavior or practices of handling leafy greens, indicating that gender, age, marital status and educational level did not significantly influence consumption patterns, shopping locations, produce storage conditions or produce washing procedures. These data on the consumption patterns and handling practices of leafy greens are important to the exposure assessment component in future risk assessment models.

INTRODUCTION

Fresh produce items are an important part of a healthy diet, since they can supply vitamins, minerals, dietary fiber and bioactive compounds. Consumption of fresh vegetables and fruits has been strongly associated with prevention of various chronic diseases, such as heart disease, stroke, type 2 diabetes and some forms of cancer *(14, 22, 40)*. The World Health Organization and the Food and Agriculture Organization of the United Nations recommend that adults consume at least 400 grams (five 80-gram portions) of fruits and vegetables per day for the prevention of chronic diseases *(39)*.

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Leafy vegetables are often consumed raw and typically require no heat treatment (e.g., cooking) before consumption, which puts consumers at microbiological risk if pathogens are present. Pathogenic microorganisms have been associated with fresh produce in several countries *(4, 9, 23, 38)*. A review of Brazilian foodborne disease outbreaks associated with fruits and vegetables and reported between 2008 and 2014 was conducted on the basis of data of the National Sanitary Surveillance Agency (ANVISA) from the Ministry of Health *(16)*. This review, which indicated that 30 produce-linked outbreaks resulted in 2926 cases, 347 hospitalizations and no deaths, represented only 0.6% of the total number of outbreaks in the period (n = 5,138). Only bacterial pathogens were identified as etiological agents, with *Salmonella* being the most frequent (30%), followed by *Staphylococcus aureus* (23.3%) *(16)*.

Quantitative microbial risk assessment (QMRA) has become an important tool in food safety, providing a structured way to estimate the probability of exposure to a microbial hazard in one or more foods as well as the health impact from that exposure. A QMRA traditionally involves four components: hazard identification, exposure assessment, hazard characterization and risk characterization. Hazard identification involves the determination of biological, chemical, and physical agents present in a food or group of foods and possibly causing adverse health effects. Exposure assessment is the evaluation of the likely intake of those agents via food or other sources. Hazard characterization estimates the relationship between the exposure level (dose) and the probability of an adverse health effect and its severity (response). Last, risk characterization is the process of estimating the probability of occurrence and severity of known or potential adverse health effects in a population, based on hazard identification, hazard characterization and exposure assessment *(11, 19)*.

Several studies using QMRA models have been conducted over the past decade to estimate the risk of foodborne illnesses due to the consumption of contaminated fresh produce *(5, 15, 20, 30, 32, 34, 37)*. Some studies addressed the impacts of cross-contamination during the washing step of these foods *(13, 28)*. Although these studies showed that fresh produce may pose a measurable risk of foodborne illnesses to consumers, they all also emphasized that more data are needed to improve the accuracy of future QMRA models and to support mitigation strategies to reduce the risks.

Characterization of the risk of foodborne illness from exposure to a microbiological hazard in a specific food (or group of foods) requires information on the frequency of consumption and amounts consumed, as well as the forms in which they are prepared and consumed. Most food consumption surveys are conducted to assess the nutritional status of a population rather than addressing consumer behavior, leading to a significant degree of uncertainty in QMRA models *(2, 3)*. The aim of this study was therefore to gather information on the consumption and handling practices regarding leafy greens of a sample drawn from the population of the city of São Paulo, Brazil, for use in future QMRA models.

MATERIAL AND METHODS

Sampling and survey instrument

A face-to-face cross-sectional questionnaire-based study was conducted by a team of interviewers in December, 2017, at two large supermarkets located in the metropolitan area of the city of São Paulo, Brazil. Approval for the study was obtained from the Faculty of Pharmaceutical Sciences Research Ethics Committee (CAAE nº 66179517.2.0000.0067). The São Paulo Supermarket Association (APAS) also provided authorization to conduct the survey in the selected supermarkets.

A two-part questionnaire was prepared to obtain data on participants' demographic characteristics as well as their consumption and handling practices of leafy greens. Part A collected data on reported gender, age, marital status and educational level, while Part B gathered data on consumption behavior and handling practices regarding leafy greens, addressing the type, frequency and amount consumed, preferred shopping location, home storage conditions and washing procedures. The amount of leafy greens consumed at each meal was determined based on kitchen measurement utensils and was converted into grams as follows: small leaf = 5.0 g, medium leaf = 10 g, large leaf = 15 g, full soup spoon = 8.0 g, full dessert plate = 30 g, and full shallow plate = 80 g. The socioeconomic status of the participants was not assessed.

The questionnaire was validated in a pilot study conducted with a group of 30 participants to assess clarity and suitability of the survey items. The questionnaire was adjusted according to the pilot study results, and the final version was applied to 225 randomly selected adults (age above 18 years), who voluntarily agreed to reply to the questions. Volunteers were approached by the interviewers at the exit of the supermarket after they had finished their shopping.

Data analyses

Descriptive analyses were performed to assess response rates. Pearson's chi-square test was used to observe possible associations of demographic characteristics of the participants (i.e., gender, age, marital status and educational level) to consumption behaviors and handling practices with regard to leafy greens. Statistical analyses were performed using the Minitab software, version 17 (2013 Minitab Inc.), and statistical significance was assumed for P-values ≤ 0.05.

RESULTS

The numbers of participants were similar between the two supermarkets with, 110 (49%) and 115 (51%) individuals participating. The demographic characteristics of the respondents are shown in *Table 1*. Participants were largely

TABLE 1. Participants' demographic characteristics

Characteristic	n (%)
Reported gender	
Female	144 (64)
Male	81 (36)
Age (years)	
18 to 30	68 (30.2)
31 to 50	75 (33.3)
51 to 60	34 (15.1)
Older than 60	48 (21.3)
Reported marital status	
Married	89 (39.6)
Single	95 (42.2)
Divorced	13 (5.8)
Widow/Widower	12 (5.3)
Common-law marriage	16 (7.1)
Educational level	
Illiterate	0 (0.0)
Incomplete elementary school	7 (3.1)
Complete elementary school	8 (3.5)
Incomplete high school	13 (5.8)
Complete high school	65 (28.9)
University education	79 (35.1)
Postgraduate education	53 (23.6)

São Paulo, Brazil, 2017 (n = 225).

female (64%), single (42.2%) and age 31–50 years (33.3%). More than one third (35.1%) of the participants reported having a graduate degree, followed by those who reported having a high school education (28.9%).

Data on the consumption behaviors and handling practices of leafy greens are shown in Table 2. Questions 6, 7 and 14 presented more than one choice as a response, and the results are shown in *Figures 1, 2 and 3*, respectively. Most respondents (97.8%) reported eating leafy greens regularly; lettuce, arugula and collard greens were the most frequently cited varieties *(Fig. 1)*. Five respondents (2.2%) reported not eating leafy greens: three males (age 18–50 years) and two females (age 18 and 30 years). Approximately half (55.9%) of those who reported eating leafy greens ate only those that were conventional (non-organic), 3.2% only organic, and 28.6% conventional and organic; 12.3% were not aware of the difference between the two types of crops.

Daily consumption of conventional leafy greens was reported by 39.5% of the respondents. The highest consumption rate among those who reported consuming organic leafy greens was once or twice a week (8.6%). The average intake among respondents was ~60 g per meal, with respondents most commonly eating the equivalent of one full dessert plate (~30 g) or one full shallow plate (~80 g) per meal.

The main shopping locations reported were farmers' markets and supermarkets (108 respondents indicated both alternatives), followed by grocery stores (n = 66) and other locations (n = 5) *(Fig. 2)*. Most respondents (98.6%) reported storing leafy greens in a refrigerator for three or more days, but one reported keeping it at room temperature

TABLE 2. Consumption behaviors and handling practices reported by the participants

Question	n (%)
Do you eat leafy greens?	
Yes	220 (97.8)
No	5 (2.2)
Do you buy conventional or organic leafy greens?	
Only conventional	123 (55.9)
Only organic	7 (3.2)
Conventional and organic	63 (28.6)
Do not know the difference	27 (12.3)
How often did you eat conventional leafy greens in the past six months?	
Daily	87 (39.5)
Once or twice a week	46 (20.9)
Three or more times per week	67 (30.4)
Every 15 days	9 (4.1)
Once per month	4 (1.8)
Did not eat	7 (3.2)
Do not know	0 (0.0)
How often did you eat organic leafy greens in the past six months?	
Daily	13 (5.9)
Once or twice a week	19 (8.6)
Three or more times per week	14 (6.4)
Every 15 days	13 (5.9)
Once per month	8 (3.6)
Did not eat	119 (54.1)
Do not know	34 (15.4)
Where do you store your leafy greens?	
Refrigerator	217 (98.6)
Room temperature	1 (0.5)
Do not know	2 (0.9)
For how long are they stored?	
Less than 24 h (consumption on the same day of shopping)	5 (2.3)
1–2 days	83 (37.7)
3 or more days	124 (56.4)
Do not know	8 (3.6)
Do you wash leafy greens before eating them?	
Yes	220 (100)
No	0 (0.0)

São Paulo, Brazil, 2017 (n = 225).

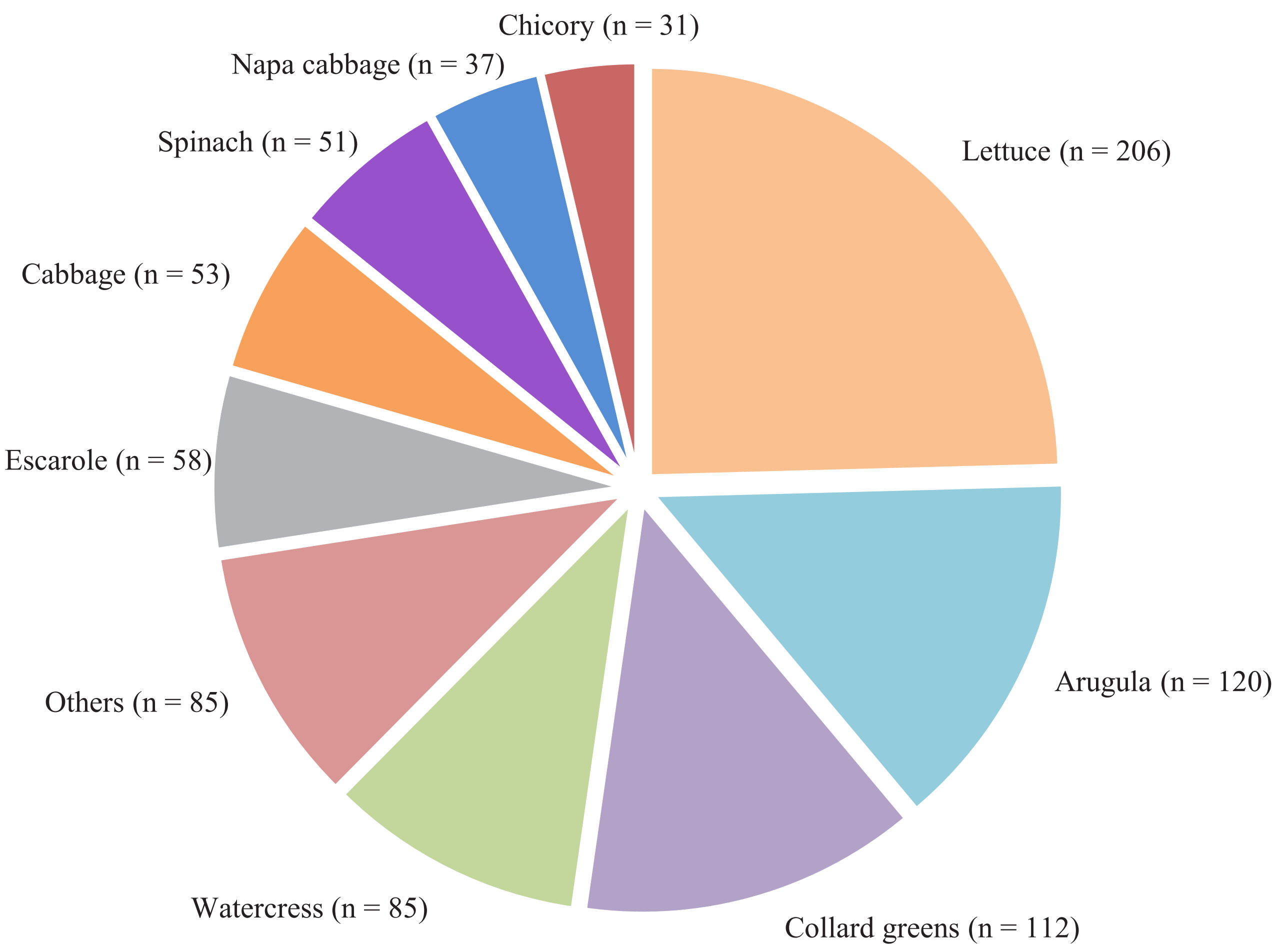

FIGURE 1. Distribution of varieties of leafy greens consumed by survey respondents.

FIGURE 2. Shopping locations of leafy greens by survey respondents.

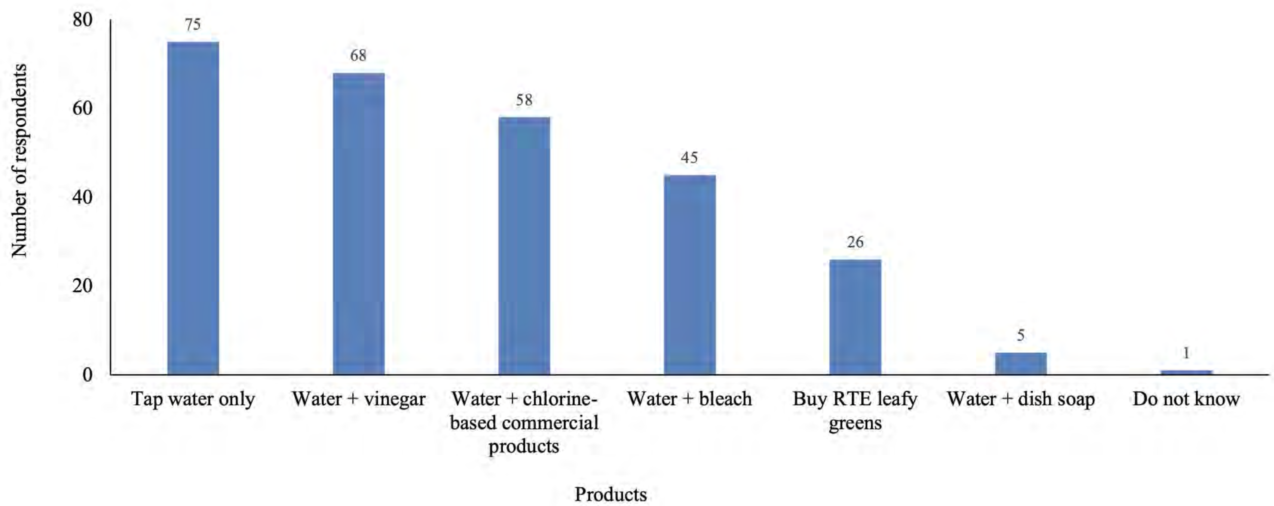

FIGURE 3. Products used for washing–disinfection of leafy greens by survey respondents.

and two did not respond. All respondents reported washing leafy greens prior to consumption, primarily using tap water only (n = 75), followed by water with culinary vinegar (n = 68) and water with commercial chlorine-based products (n = 58) or bleach (n = 45). Five respondents reported using dish soap, while 26 reported eating bagged ready-to-eat leafy greens *(Fig. 3)*.

Results of Pearson's chi-square test indicated the absence of a statistically significant relationship ($P \geq 0.05$) between the demographic characteristics of participants and consumption behavior or handling practices of leafy greens, indicating that gender, age, marital status and educational level were not significantly correlated with consumption patterns, choice of shopping locations, storage conditions or washing procedures.

DISCUSSION

The available information on food consumption patterns in Brazil are derived from limited population-based studies or family budget surveys carried out by the Brazilian Institute of Geography and Statistics — IBGE, designed to measure the average availability of foods in households *(12, 24)*. The latest IBGE report refers to 2008–2009 and indicates that the average consumption of leafy greens across Brazil in that timeframe was ~25 g/day *(24)*.

A national survey based on 53,210 telephone interviews conducted in Brazil between February and December 2016 indicated that 35.2% of the surveyed adults above 18 years old consumed fruits and vegetables five or more days per week *(8)*. The Dietary Guidelines for the Brazilian Population of the Brazilian Ministry of Health do not establish the number of servings for each type of food but recommends daily intake of fruits and vegetables *(7)*.

The results of our study partially corroborate previously published data on daily intake of fresh foods. The results of the Brazilian survey *(8)* indicating that 35.2% of participants ate raw fruits and vegetables five or more days per week are in approximate agreement with the 39.5% rate we found for reported daily consumption of leafy greens. On the other hand, the reported consumption levels were quite different, as we found an average serving size of ~60 g, while the IBGE reported a ~25 g average serving size *(24)*. These differences may be due to different geographical scopes, as the IBGE report was for all Brazilians, while ours focused only on residents of São Paulo.

The 2015–2020 Dietary Guidelines for Americans (USA) states that individuals requiring 2,000 calories per day should include the equivalent of 2 cups of fruits and 2.5 cups of vegetables in their daily diets. USDA food consumption surveys have found that the average American falls far short, consuming the equivalent of only 0.9 cups of fruits and 1.4 cups of vegetables per day *(36)*. The European Freshfel Consumption Monitor indicates that the consumption of fresh fruits and vegetables by EU citizens in 2014 was 353 grams per capita per day (192 grams of fruits and 161 grams of vegetables), a decrease of 0.75% compared with the mean of the previous five years (2009–2013) *(21)*. Data from Brazil, the United States and the European Union reveal a lower daily consumption of fruits and vegetables than that recommended by the World Health Organization and the Food and Agriculture Organization of the United Nations (400g/day) *(39)*.

All respondents in our study who consumed leafy greens reported washing them before eating *(Table 2)*, even those who purchased pre-washed products *(Fig. 3)*. A 2007 U.S. panel of scientists reviewing guidelines for consumer handling of prewashed bagged salads concluded that packaged ready-to-eat products produced in a properly operated inspected facility does not need additional washing unless the need for washing is specifically stated on the label *(31)*.

Some respondents mentioned using bleach or commercial chlorine-based products for disinfection. This provides some evidence of the general awareness of the need to wash and disinfect raw vegetables before consumption, and commercial chlorine-based products can be found easily in most supermarkets in the country. Although there is a recommendation for use of sodium hypochlorite (200–250 mg/l) for disinfection of fresh produce in processing sites *(6)*, several studies have shown that chlorine´s effectiveness in reducing the microbial load on vegetables depends on the level of organic load, and that there is a risk of toxic by-products formation, highlighting the need of rinsing with water after using chlorine to wash produce *(18)*.

A large number of respondents reported adding culinary vinegar to wash water for disinfection of leafy greens *(Fig. 3)*, although the effectiveness of organic acids (e.g., acetic acid) against foodborne pathogens depends on pH, type and concentration of the acid, type of vegetable, strain of microorganism, inoculum level and treatment time *(1, 10, 17, 26, 29, 33, 35)*. High concentration of organic acids and long contact times may also impact the organoleptic properties of leafy vegetables. Some respondents mentioned using water and dish soap for washing leafy greens, although this practice should be avoided, as it may cause gastric disorders or other symptoms *(27)*.

Consumption surveys should always be interpreted with care, as responses may be specific to a given geographic region. A similar survey of consumer handling practices for fresh produce carried out in Spain and Belgium, with 583 and 1,605 respondents, respectively, revealed differences in the two countries. Vegetable consumption was higher in Spain than in Belgium, whereas the opposite was found for fruit consumption. Belgian consumers stored their fresh produce in a refrigerator less frequently, and when they did so, for shorter times compared with Spanish consumers. Few consumers failed to wash head lettuce (1% in Belgium and 2% in Spain), but 50% of the Belgian respondents and 67% of Spanish respondents did not wash prepackaged greens *(25)*. Our data add to this growing body of literature, all of which may be useful in future risk assessment studies.

Our study contributes local data on the quantitative consumption estimates and handling practices of leafy greens by São Paulo residents, which are essential to support the accuracy of exposure assessments in the construction of risk assessment models. The data indicated an average consumption of ~60 g per meal (~60 to 120 g per day) and identified handling practices that would be useful in predicting foodborne illnesses in leafy green quantitative microbial risk assessments. The results also evidence the need for education and handling tips for consumers regarding best practices for leafy greens, focusing specifically on not washing ready-to-eat produce and avoiding the use of soap for leafy greens that need to be washed.

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