

AN INVESTIGATION OF INDICATOR BACTERIA IN READY-TO-EAT SALADS FROM RETAIL STORES IN TORONTO, ONTARIO, CANADA

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BACKGROUND

Ready-to-eat (RTE) salads have become popular worldwide due to their convenience and nutritional value (1). Eating fresh vegetables has been linked to outbreaks worldwide, since these can be easily contaminated during handling or processing (2).

Vegetables have several intrinsic and extrinsic qualities that could provide an environment to support pathogen growth, including: pH, water activity, nutrients, temperature, equipment, washing, and worker handling (1).

In all areas of retail, from storage to checkout, cleaning and sanitizing should be used to minimize the spread of bacteria (3). Disinfection is a critical step in the processing of fresh-cut vegetables since it affects the end products shelf-life, quality, and safety (1).

Biofilms cannot be fully eliminated from vegetables through conventional cleaning and sanitation procedures, since microorganisms found within vegetable biofilms are known to be tolerant to physical and chemical disinfectants (4). Bacterial cells imbedded in vegetable structures (i.e. stomata, trichomes) and bacteria found in surface imperfections are able to avoid disinfection through the protection of a biofilm (1, 4, 5).

PURPOSE

The objective of this study is to investigate *Escherichia coli* and total coliform contamination in Ready-to-Eat salads sold in retail stores.

MATERIALS AND METHODS

A total of 26 salads were purchased from 12 retail stores. At each store 2 salads were selected, one containing kale and the other spinach. 2 stores had either kale or spinach available, and one store was sampled on both days. Notes were recorded after each purchase on employee conversations.

After the salads were purchased, they were transported in an insulated lunch bag surrounded with ice packs to Ryerson University's School of Occupational and Public Health Laboratory. This is where samples were prepared under aseptic techniques, and salad weights and ingredients were recorded.

Samples were then sealed into a styrofoam cooler surrounded by ice packs and couriered overnight to the University of Guelph food laboratory for testing.

Table 1. Indicator Organism Results for 26 Ready-to-Eat Salads, Obtained in November 2018 From 12 Retail Stores in Toronto, Ontario

Indicator Organism	Number of Samples (Prevalence %)				
	< 1.0E+01*	1.0E+01 to < 1.0E+02	1.0E+02 to < 1.0E+03	1.0E+03 to < 1.0E+04	1.0E+04 to < 1.0E+05
Total Coliform	8 (30.8%)	6 (23.1%)	5 (19.2%)	0 (0%)	7 (26.9%)
<i>Escherichia coli</i>	26 (100.0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)

*Lower limit of detection was 1.0E+01 CFU/g.

Table 2: Total Coliform Results for 13 Kale and 13 Spinach RTE Salad Samples From 12 Retail Stores In Toronto, Ontario

	Number of Samples (% of 13)				
	< 1.0E+01*	1.0E+01 to < 1.0E+02	1.0E+02 to < 1.0E+03	1.0E+03 to < 1.0E+04	1.0E+04 to < 1.0E+05
Kale	1 (7.7%)	4 (30.8%)	4 (30.8%)	0 (0%)	4 (30.8%)
Spinach	7 (53.9%)	2 (15.4%)	1 (7.7%)	0 (0%)	3 (23.1%)

*Lower limit of detection was 1.0E+01 CFU/g.

Table 3: Ingredients in 7 Samples Found within 1.0E+04 to < 1.0E+05 CFU/g Total Coliform Range (n=26)

Ingredient	No. of Samples	% Contaminated	Total Samples	% of Total
Dried Cranberries	6	85.7%	14	42.9%
Kale	4	57.1%	13	30.8%
Spinach	3	42.9%	13	23.1%
Cabbage	3	42.9%	9	33.3%
Strawberries	3	42.9%	8	37.5%
Walnuts	3	42.9%	8	37.5%
Mandarin Oranges	2	28.6%	5	40.0%
Sunflower Seeds	2	28.6%	4	50.0%
Blueberries	1	14.3%	4	25.0%

Table 4: Ingredients in the 8 Samples with < 1.0E+01 CFU/g Total Coliform (n=26)

Ingredient	No. of Samples	% of 8 Samples	Total Samples	% of Total
Spinach	7	87.5%	13	53.8%
Dried Cranberries	5	62.5%	14	35.7%
Strawberries	4	50.0%	8	50.0%
Walnuts	4	50.0%	8	50.0%
Blueberries	3	37.5%	4	75.0%
Cabbage	2	25.0%	9	22.2%
Mandarin Oranges	2	25.0%	5	40.0%
Pomegranate Seeds	2	25.0%	3	66.7%
Kale	1	12.5%	13	7.7%
Sunflower Seeds	1	12.5%	4	25.0%

RESULTS

All 26 samples tested below the limit of detection for *E. coli*.

Total coliforms were detected in all samples and ranged from < 1.0E+01 CFU/g to 4.3E+04 CFU/g (median = 6.5E+01; mode = < 1.0E+01). Within this range, 26.9% (7/26) of samples contained 1.0E+04 CFU/g or higher amounts of total coliform, while 30.8% (8/26) of samples were found to be below the limit of detection.

Kale and spinach were listed first on nutrition labels, indicating that they were the majority ingredient in each salad provided for testing. 30.8% (4/13) of kale samples and 23.1% (3/13) of spinach samples were found with total coliform amounts of 1.0E+04 and above. Only 1 (7.7%; 1/13) of kale samples and the majority (53.9%; 7/13) of spinach samples were found to be below the limit of detection.

While talking with food handlers about the process of making their RTE salads, they all stated that the salads were washed and ready for consumption immediately. When pressed about whether or not they themselves washed the kale or spinach before it was packaged, most of the food handlers stated they did not wash it themselves but that it arrived in store pre-washed.

DISCUSSION

The *E. coli* amounts found indicate that all samples are of good microbiological quality, but their presence could indicate poor sanitation and inadequate processing (6, 7).

Since Enterobacteriaceae and total coliforms are regularly found at high levels on fresh fruits and vegetables normal flora, no satisfactory or unsatisfactory limit can be applied (6, 7). Their presence, however, can indicate that unsanitary practices were used during the handling or processing of these salads (7).

Public Health Significance: Since this study and previous studies indicate that fresh leafy greens can be contaminated with indicator bacteria, these products can be a risk to the public if contaminated with pathogenic bacteria. Especially since previous studies have indicated that bacteria may be imbedded in leafy vegetable structures, and there are no steps required by consumers to clean RTE foods before consumption.

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