Canadian Food Inspection Agency | Agence canadienne d'inspection des aliments

Bacterial pathogens and indicators in dried fruit and vegetable powders for smoothies - April 1, 2022, to March 31, 2023

Food microbiology - Targeted surveys - Final report

Canada

Summary

A 1-year targeted survey[1] analyzed 71 samples of dried fruit and vegetable powders for smoothies for the presence of the pathogens S*almonella* species (spp.) and *Escherichia coli* (*E. coli*) O157. All samples were also tested for generic *E. coli* which is an indicator of the overall hygienic and sanitary conditions of the food supply chain from production to the point of sale.

All (100%) of the 71 samples tested were found to be satisfactory. *Salmonella* spp., *E. coli* O157, and generic *E. coli* (>10^2 most probable number (MPN)/g) were not found in any of the samples.

Overall, our survey results indicate that dried fruit and vegetable powders for smoothies sold in Canada are generally safe for consumption. However, as with all foods, and especially those that are ready-to-eat (RTE), good hygienic practices are recommended for producers, retailers, and consumers.

Why the survey was conducted

The survey was conducted to generate information on the quality and safety of dried fruit and vegetable powders for smoothies sold at retail in Canada. Similar surveys were conducted from 2014 to 2018 of dried sprouted seeds[2] and from 2016 to 2018 of seed powders and plant-based protein powders[3].

The consumption of dried fruit and vegetable powders have grown in popularity as a convenient and healthy means of adding nutrients to smoothies and other foods. As a result, an increasing variety of dried fruit and vegetable products have appeared on the Canadian retail marketplace.

A variety of fruits and vegetables are used to make dried powders[4,5] and their production involves several steps post-harvest. Once the fruits and vegetables are prepared (washed, peeled, sliced), they are then dried using various drying or dehydration techniques[6,7] and then milled into a powder.

Unfortunately, plant-based powders have been associated with recalls[8] and foodborne illness outbreaks[8]. Contamination with bacterial pathogens can occur at any step in the food supply chain such as during primary production, harvest, processing, and/or packaging. Also, as these products are low moisture foods, bacterial pathogens can survive for extended periods of time[6]. Consequently, if pathogens are present, there is a potential for foodborne illness as dried fruit and vegetable powders for smoothies are RTE.

When the survey was conducted

The survey was conducted over a 1-year period from April 1, 2022, to March 31, 2023.

Where the samples were collected from

Samples were collected from national retail chains and local/regional grocery stores located in the following 6 major cities across Canada:

- Quebec City
- Montreal
- Toronto
- Ottawa
- Vancouver
- Calgary

The planned number of samples to be collected from each city was based on the population of the province in which the city was located relative to the total population of Canada.

Total number and description of samples collected

A total of 71 dried fruit and vegetable powder samples which were labeled for use in smoothies or beverages were collected. A sample consisted of a single or multiple consumer sized packages of the same lot weighing at least 150g.

What the samples were tested for

All samples were tested for *Salmonella* spp., *E. coli* O157 and generic *E. coli*. *Salmonella* spp., and *E. coli* O157 are pathogenic bacteria while generic *E. coli* is an indicator of the overall hygienic and sanitary conditions under which the samples have been produced, processed, stored, and transported.

Methods used to test the samples

Samples were analyzed using analytical methods published in Health Canada's *Compendium of Analytical Methods for the Microbiological Analysis of Foods*[9] that were appropriate for the testing of dried fruit and vegetable powders.

How the samples were assessed

The samples were assessed using criteria based on the principles of Health Canada's *Health Products and Food Branch Standards and Guidelines for Microbiological Safety of Food – An Interpretive Summary*[10], the *Food and Drugs Act*[11] (Section 4(1)), and guidelines developed by international food safety authorities[12,13].

Table 1 - Assessment criteria

Bacteria	Satisfactory	Investigative	Unsatisfactory
Salmonella spp.	Not detected/25g	Not applicable	Detected/25g
E. coli O157	Not detected/25g	Not applicable	Detected/25g
Generic *E. coli*	≤ 10^2 MPN/g	> 10^2 MPN/g	Not applicable

No assessment guidelines had been established in Canada for the presence of *Salmonella* spp., *E. coli* O157 or indicator organisms in dried fruit and vegetable powders at the time of writing this report.

As *Salmonella* spp. and *E. coli* O157 are considered pathogenic to humans, the presence of either organism would be assessed as unsatisfactory as this might be considered a violation of the *Food and Drugs Act*[11] Section 4(1)a.

Unlike bacterial pathogens, most strains of generic *E. coli* are harmless. Generic *E. coli* is considered to be an indicator organism as their levels present in a food product are used to assess the overall sanitation conditions throughout the food chain from production to the point of sale. Their presence at some levels is tolerated, however elevated levels were assessed as investigative, possibly resulting in further follow-up actions.

Survey results

All 100% of the samples tested were found to be satisfactory. *Salmonella* spp., *E. coli* O157 and generic *E. coli* (>10^2 MPN/g) were not found in any of the samples.

Table 2 - Analysis assessment results

Bacterial analysis	Number of samples tested	Satisfactory (%)	Investigative	Unsatisfactory
Salmonella spp.	71	71	Not applicable	0
E. coli O157	71	71	Not applicable	0
Generic *E. coli*	71	71	0	Not applicable
Total	**71**[a]	**71 (100.0)**	**0**	**0**

[a] All 71 samples were tested for the presence of *Salmonella* spp., *E. coli* O157, and generic *E. coli.*

Survey results are also presented by production practice (table 3), origin (table 4), and product type (table 5).

Table 3 - Assessment results by production practice

Production practice	Number of samples tested (%)	Satisfactory
Conventional	10 (14.1)	10
Organic	61 (85.9)	61
Total	**71 (100.0)**	**71**

Table 4 - Assessment results by product origin

Origin	Number of samples tested (%)	Satisfactory
Domestic	3 (4.2)	3
Import	57 (80.3)	57
Unknown[b]	11 (15.5)	11
Total	**71 (100.0)**	**71**

Table 5 - Assessment results by product type

Product type	Number of samples tested (%)	Satisfactory
Acai berry	3 (4.2)	3
Amla berry	5 (7.0)	5
Apple	2 (2.8)	2
Artichoke	2 (2.8)	2
Baobab fruit	3 (4.2)	3
Beet root	7 (9.9)	7
Blueberry	1 (1.4)	1
Camu camu berry	7 (9.9)	7
Goji berry	2 (2.8)	2
Lucuma	2 (2.8)	2
Maca	17 (23.9)	17
Moringa leaf	5 (7.0)	5
Mung beans	1 (1.4)	1
Pomegranate	5 (7.0)	5
Raspberry	1 (1.4)	1
Sweet potato	2 (2.8)	2
Triphala	2 (2.8)	2
Tumeric	1 (1.4)	1
Turnip	3 (4.2)	3
Total	**71 (100.0)**	**71**

[b] The product origin could not be assigned from the product label or available sample information.

What the survey results mean

Previously published Canadian studies[2,3] investigated the microbiological quality and safety of similar products. All of the samples in the current study were found to be satisfactory, while 97%[2] and 98%[3] of the samples in the previous studies were found to be satisfactory. Differences in the % satisfactory rate between studies are most likely due to differences between product types tested.

Overall, our survey results indicate that dried fruit and vegetable powders for smoothies sold in Canada is generally safe for consumption. However, as with all foods, and especially with those that are RTE, good hygienic practices are recommended for producers, retailers, and consumers.

What is done with the survey results

All results are used to:

- inform risk management decisions
- support program design and re-design

Where to access the survey data

The data will be accessible on the Open Government Portal.

References

1. Canadian Food Inspection Agency, Food chemistry and microbiology.
2. Canadian Food Inspection Agency, Bacterial Pathogens in Dried Sprouted Seed Products – November 1, 2014 to March 31, 2018. 2019.
3. Canadian Food Inspection Agency, Bacterial Pathogens in Seed Powder and Plant-Based Protein Powder – April 1, 2016 to March 31, 2018. 2019.
4. Jiang, H., et al., *21 - Fruit and vegetable powders, in Handbook of Food Powders,* B. Bhandari et al., Editors, 2013, Woodhead Publishing. p. 532-552.
5. Dilrukshi, S.H.B. and H.P.S. Senarath, *Development and Quality Evaluation of Freeze-Dried Instant Green Smoothie Powder*. International Journal of Food Science, 2021. 6634764, 7 pages.
6. Bourdoux, S., et al., *Performance of Drying Technologies to Ensure Microbial Safety of Dried Fruits and Vegetables.* Comprehensive Reviews in Food Science and Food Safety, 2016. 15(6): p.1056-1066.
7. Ratti, C., *Hot air and freeze-drying of high-value foods: a review.* Journal of Food Engineering, 2001. 49(4): p.311-319.
8. Centers for Disease Control and Prevention, *2016 Salmonella Outbreak Linked to Garden of Life RAW Meal Organic Shake & Meal Products*. 2016.
9. Health Canada, *Compendium of Analytical Methods*. 2011.
10. Health Canada, *Health Products and Food Branch (HPFB) Standards and Guidelines for Microbiological Safety of Food - An Interpretive Summary*. 2008.
11. Health Canada, *Food and Drugs Act,* RSC 1985 c F-27. 1985.
12. UK Health Protection Agency, Guidelines for Assessing the Microbiological Safety of Ready-to-Eat Foods Placed on the Market (PDF). 2009.
13. Hong Kong Centre for Food Safety, Microbiological Guidelines for Food (For ready-to-eat food in general and specific food items) (PDF). 2014.