



Canadian Food
Inspection Agency

Agence canadienne
d'inspection des aliments

Food Microbiology – Targeted Surveys

FINAL REPORT

Bacterial Pathogens in Edible Insects

April 1, 2017 – March 30, 2018



Summary

The consumption of edible insects has a long history in Africa, Asia and Latin America. In recent years there has been an increased interest in eating edible insects in Europe and North America. Consequently, a growing number of edible insect products have become available to Canadians, such as dried whole insects, insect powder, and insect-containing snacks (e.g., chips, crackers, and cookies). Edible insects are promoted to be a sustainable, cost effective source of protein, thereby ensuring future food security. Although most of the popular edible insects around the world have a history of safe use for human consumption, edible insects are not traditionally consumed by the Canadian population. Little scientific information is available regarding the control of microbiological pathogens during the rearing and processing of edible insects. Nevertheless, edible insects produced for human consumption and available to Canadian consumers must meet the same safety and hygiene standards as other foods available in Canada.

Considering the factors mentioned above and their relevance to Canadians, edible insects were selected to be part of a preliminary survey to gain basic food safety information. Over the course of this study (April 1, 2017 – March 30, 2018), a total of 51 samples of edible insects (dried whole insects or insect powder) were acquired from online retailers or collected at physical retail establishments in Canada. Samples were tested for the bacterial pathogen *Salmonella* species (spp.) and generic *Escherichia coli* (*E. coli*) which is an indicator of the overall sanitation conditions throughout the food production chain.

Salmonella spp. and generic *E. coli* (>100 Colony Forming Units (CFU)/g) were not found in any of the samples analysed and therefore it appears that the edible insects have been produced under sanitary conditions. As the number of samples, product types and microorganisms tested for in our study were limited, our results have been interpreted with caution. Further studies are required to determine whether current industry practices regarding the rearing, processing, handling and storage of edible insects result in the production of food-grade products. Consequently, as with all foods, safe food handling practices are recommended for producers, retailers and consumers.

What Are Targeted Surveys?

Targeted surveys are used by the Canadian Food Inspection Agency (CFIA) to focus its surveillance activities on areas of highest health risk. The information gained from these surveys provides support for the allocation and prioritization of the Agency's activities to areas of greater concern. Originally started as a project under the Food Safety Action Plan (FSAP), targeted surveys have been embedded in the CFIA's regular surveillance activities since 2013. Targeted surveys are a valuable tool for generating information on certain hazards in foods, identifying and characterizing new and emerging hazards, informing trend analysis, prompting and refining health risk assessments, highlighting potential contamination issues, as well as assessing and promoting compliance with Canadian regulations.

Food safety is a shared responsibility. The Canadian Food Inspection Agency works with federal, provincial, territorial and municipal governments and provides regulatory oversight of the food industry to promote safe handling of foods throughout the food production chain. The food industry and retail sectors in Canada are responsible for the food they produce and sell, while individual consumers are responsible for the safe handling of the food they have in their possession.

Why Did We Conduct This Survey?

The consumption of edible insects has a long history in Africa, Asia and Latin America¹. In recent years, edible insects have been promoted as a promising future alternative source of protein to the current mainstream staples of beef, pork and chicken¹. Therefore, a growing number of edible insect products have appeared on the Canadian market in recent years such as whole and powdered insects. Dried whole insects (roasted, smoked, flavoured) are to be consumed "as is" while powdered insects are suggested for use as ingredients in other foods or in processed products such as protein bars, chips, crackers and cookies. Edible insect products are available for purchase by Canadian consumers online, at specialty stores and at mainstream grocery stores. Although most of the popular species of edible insects used as food around the world have a history of safe use for human consumption¹, edible insects have not been traditionally consumed by the Canadian population. To date, no specific regulations, standards, or guidelines regarding the sale and the production of edible insects (from farming, processing and storage) have been established in Canada. Edible insects are considered to be novel foods by the European Food Safety Authority (EFSA) and therefore are subject to approval², while a few countries (e.g., Belgium) in the EU permit the marketing and sale of certain edible insects species³. Nevertheless, edible insects produced for human consumption

and available to Canadian consumers must meet the same safety and hygiene standards as other foods available in Canada⁴.

Considering the factors mentioned above and their relevance to Canadians, edible insects were selected to be part of a preliminary survey to gain basic safety information. This report details results of the survey period of April 1, 2017 to March 31, 2018.

What Did We Sample?

For this survey, a sample consisted of a single or multiple unit(s) (e.g., individual consumer-sized packages from a single lot) with a total weight of at least 50 g. All samples were acquired from online retailers or collected at physical retail establishments located in Ottawa, Canada. A variety of insect species in dried whole and powdered form were collected including domestic, imported, conventional or organic products.

What Analytical Methods Were Used and How Were Samples Assessed?

Samples were analyzed for the bacterial pathogen *Salmonella* species (spp.) and generic *Escherichia coli* (*E. coli*) using methods published in Health Canada's *Compendium of Analytical Methods for the Microbiological Analysis of Foods*⁵. See Table 1 for the specific methods used and associated assessment criteria

No microbiological guidelines had been established in Canada for the presence of *Salmonella* spp. in edible insects at the time of writing this report. As *Salmonella* is considered pathogenic to humans its presence in foods was considered to be a violation of the *Food and Drugs Act* (FDA)⁴ Section 4(1)a and therefore was assessed by the CFIA as unsatisfactory.

Unlike bacterial pathogens such as *Salmonella*, generic *E. coli* is commonly found in the intestines of humans and most strains are harmless. It is considered to be an indicator organism and levels of generic *E. coli* found in a food product are used to assess the overall sanitation conditions throughout the food chain from production to the point of sale. Its presence at some levels is tolerated on agricultural products. An investigative assessment which may result in further follow-up actions is associated with elevated levels of generic *E. coli* ($100 < x \leq 1000$ Colony Forming Units (CFU)/g). As the results are based on the analysis of one unit (n=1), further sampling is required to verify the levels of generic *E. coli* of the lot. An unsatisfactory assessment is associated with high levels of generic *E. coli* (> 1000 CFU/g) as it may indicate a breakdown in Good Agricultural Practices, and therefore possibly warranting the

initiation of follow-up activities to determine the source of the contamination and improve sanitation conditions along the food chain.

Table 1 - Analytical Methods and Assessment Criteria for *Salmonella* and Generic *E. coli* in Edible Insect Samples

Bacterial Analysis	Method Identification Number*	Assessment Criteria		
		Satisfactory	Investigative	Unsatisfactory
<i>Salmonella</i> spp.	MFLP-29 MFHPB-20	Absent in 25g	Not Applicable (N/A)	Present in 25g
Generic <i>E. coli</i>	MFHPB-34	≤ 100 CFU/g	$100 < x \leq 1000$ CFU/g	> 1000 CFU/g

* The methods used were the published versions at the time of analysis

What Were The Survey Results?

Over the course of this study (April 1, 2017 – March 31, 2018), a total of 51 samples were collected. *Salmonella* spp. and generic *E. coli* (> 100 CFU/g) were not found in any samples. Sample assessment results can be found in Table 2.

Table 2 - Assessment Results of Edible Insect Samples

Bacterial Analysis	Number of Samples Tested	Satisfactory	Investigative	Unsatisfactory
<i>Salmonella</i> spp.	51	51	N/A	0
Generic <i>E. coli</i>			0	
Total	51	51	0	0

Of the 51 samples tested, 31 (61%) were dried whole insect samples and 20 (39%) were powdered insect samples. These products were either produced in Canada (18/51, 35%) or imported (33/51, 65%) from five countries (Table 3).

Table 3 - Country of Origin of Edible Insect Samples

Country of Origin	Number of Samples (% of Total Samples)	Product Forms	
		Number of Whole Samples (% of Total Samples)	Number of Powder Samples (% of Total Samples)
Domestic	18 (35.3)	9	9
Import	33 (64.7)	22	11
<i>France</i>	2	2	0
<i>Thailand</i>	11	8	3
<i>United Kingdom</i>	2	1	1
<i>United States</i>	15	9	6
<i>Zambia</i>	3	2	1
Total	51 (100)	31 (61)	20 (39)

A variety of insect species were analysed (Table 4).

Table 4 - Insect Species of the Samples Analysed

Insect Species (common name)	Number of Samples Tested (% of Total Samples)	Product Form	
		Number of Whole Samples	Number of Powdered Samples
Bamboo worm	1 (2)	1	0
Black ants	1 (2)	1	0
Buffalo worm	1 (2)	1	0
Chapulines	1 (2)	1	0
Cricket	31 (61)	14	17
Earthworm	1 (2)	0	1
Grasshoppers	2 (4)	2	0
Locust	1 (2)	1	0
Mealworms	5 (10)	4	1
Mopane worms	1 (2)	1	0
Silkworms	2 (4)	1	1
Superworms	2 (4)	2	0
Weaver ants	2 (4)	2	0
Total	51	31	20

What Do The Survey Results Mean?

In this preliminary survey, *Salmonella* spp. and generic *E. coli* (>100 CFU/g) were not found in any samples (51) analyzed.

Very few studies have been conducted to investigate the microbiological safety and quality of insects produced for human consumption. Similar to our survey results, a preliminary study conducted in Germany between 2014 and 2015⁶ did not find the presence of *Salmonella*, or generic *E. coli* (>100 CFU/g) in 38 retail samples of edible insects. The German study did however identify the presence of *Bacillus cereus* and *Pseudomonas* spp. in dried and powdered processed insect products, which are bacterial pathogens capable of causing infections in immunocompromised patients⁶. Another study conducted in the Netherlands between 2015 and 2016⁷ did not detect any genetic material of *Salmonella* spp., but did detect the presence of genetic material of *Listeria* spp. and *Staphylococcus* spp. in processed edible insects purchased from one local company. Some studies reported that the total bacterial load (aerobic bacterial counts) of raw insects was higher than in raw ground meat, and therefore an effective heat treatment (sterilization) is required to reduce the total microflora load, including gut flora and spore-forming bacteria^{8,9,10}. The scientific committee of the Federal Agency for the Safety of the Food Chain of Belgium has recommended a heat inactivation step (sterilization) as being essential to control microbial hazards in the final edible insect products³.

The edible insects analysed in our survey appear to have been produced under sanitary conditions. As the number of samples, product types and microorganisms tested for in our study were limited, our results have been interpreted with caution. Further studies are required to determine whether current industry practices regarding the rearing, processing, handling and storage of edible insects result in the production of food-grade products. Consequently, as with all foods, safe handling practices are recommended for producers, retailers and consumers.

References

1. Food and Agriculture Organization of the United Nations *Edible Insects -Future prospects for food and feed security* Available from <http://www.fao.org/docrep/018/i3253e/i3253e.pdf>.
2. EFSA Scientific Committee, Risk profile related to production and consumption of insects as food and feed *EFSA* **2015**, *13* (10), 4257.
3. Scientific Committee of the Federal Agency of the Safety of the Food Chain *Food safety aspects of insects intended for human consumption (SciCom dossier 2014/04; SHC dossier n° 9160)*. Available from <http://www.afsca.be/scientificcommittee/opinions/2014/ documents/Advice14-2014 ENG DOSSIER2014-04.pdf>.
4. Department of Justice Canada. *Food and Drugs Act* 2014. <http://laws-lois.justice.gc.ca/eng/acts/F-27/> (accessed 2015).
5. Health Canada. *Compendium of Analytical Methods [online]* [Online], 2011. <http://www.hc-sc.gc.ca/fn-an/res-rech/analy-meth/microbio/index-eng.php> (accessed 2016).
6. Grabowski, N. T.; Klein, G., Microbiology of processed edible insect products - Results of a preliminary survey, *International journal of food microbiology* **2017**, *243*, 103. doi: 10.1016/j.ijfoodmicro.2016.11.005.
7. Garofalo, C.; Osimani, A.; Milanovic, V.; Taccari, M.; Cardinali, F.; Aquilanti, L.; Riolo, P.; Ruschioni, S.; Isidoro, N.; Clementi, F., The microbiota of marketed processed edible insects as revealed by high-throughput sequencing, *Food microbiology* **2017**, *62*, 15. doi: 10.1016/j.fm.2016.09.012.
8. Caparros Megido, R.; Desmedt, S.; Blecker, C.; Béra, F.; Haubruge, É.; Alabi, T.; Francis, F., Microbiological Load of Edible Insects Found in Belgium, *Insects* **2017**, *8* (1), 12. doi: 10.3390/insects8010012.
9. Grabowski, N. T.; Klein, G., Microbiology of cooked and dried edible Mediterranean field crickets (*Gryllus bimaculatus*) and superworms (*Zophobas atratus*) submitted to four different heating treatments, *Food science and technology international = Ciencia y tecnologia de los alimentos internacional* **2017**, *23* (1), 17. doi: 10.1177/1082013216652994.
10. Schluter, O.; Rumpold, B.; Holzhauser, T.; Roth, A.; Vogel, R. F.; Quasigroch, W.; Vogel, S.; Heinz, V.; Jager, H.; Bandick, N.; Kulling, S.; Knorr, D.; Steinberg, P.; Engel, K. H., Safety aspects of the production of foods and food ingredients from insects, *Molecular nutrition & food research* **2017**, *61* (6). doi: 10.1002/mnfr.201600520.