Risks Associated With The Consumption of Fresh Sprouts

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Abstract

Seed sprouts have emerged as a significant source of foodborne illness and consumption of fresh sprouts has become a public health concern of some magnitude. The failure of efforts by regulatory authorities and industry to ensure the safety of the product resulted in raw sprouts being declared, in the U.S., a high-risk food to the general public. New U. S. Food and Drug Administration guidelines require the treatment of seeds to be followed by microbial testing of the spent irrigation water from each batch of sprouts prior to distribution. Several methods were used to communicate the risks to the public, including press releases and health hazard alerts from authorities, widespread media coverage, public meetings, and scientific reports in journals. There has been little public discussion in Canada. The effectiveness of the risk management and communication strategies used is unclear as there are still numerous reports of sprout-associated outbreaks.

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Introduction and Background

The consumption of seed sprouts is increasingly popular in North America and other parts of the world, consistent with a recent increase in consumption of fresh fruits and vegetables. Chemical analysis has shown that sprouts contain proteins, carbohydrates, minerals, and vitamins, thus it is a nutritious food and a good option for vegetarians (1). Further, epidemiological studies suggest that sprouts may have a beneficial role in protecting against a number of chronic diseases and conditions such as various types of cancers, osteoporosis and menopausal symptoms (2, 3, 4). Studies conducted at John Hopkins University in 1997 concluded that raw broccoli sprouts may be rich in sulforaphane, a product that reduces the risk of cancer (4). It is estimated that 10 per cent of Americans eat sprouts regularly (4) and sprouted seeds have also enjoyed popularity in Canada in recent times. However, over the past decade, the consumption of seed sprouts has been linked to multiple outbreaks of foodborne illness throughout the world, affecting thousands of people (4).

This paper is a review of the foodborne risks associated with the consumption of sprouts and the steps being taken to reduce those risks. The science of sprout contamination, current state of scientific knowledge, and good agricultural practices are reviewed. Additionally, the paper will review the risk communication strategies used to inform the public, and high risk groups in particular, about the risks associated with eating raw seed sprouts, as well as a comparative analysis of U. S. and Canadian risk management and communication strategies

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Microbial risks

The production of sprouts has become a growth industry in response to consumer demands for continuous supplies of fresh produce. The U. S. market is valued at approximately $ 25 million with over 400 growers producing 300,000 tons of sprouts annually (4). Alfalfa sprout is the most

common form of green sprouts available, and it was implicated in most of the sprouts-associated outbreaks in the U. S. from 1995 to 1999 (5). Microbiological analyses have shown that alfalfa seeds routinely contained high levels of microbial flora, including coliforms and fecal coliforms (5, 6). Of even greater public health significance however, is the fact that pathogens can exceed 10^7 per gram of sprouts without affecting the appearance of the product (6). In respect to bacterial growth and proliferation, sprouts present a special risk compared to other fresh produce. The conditions under which they are produced -growing time, temperature, moisture, and nutrients -are ideal for bacterial proliferation (1, 6). The microbial flora of sprouts were, therefore, often 2 to 3 logs higher than that observed in seeds (1, 7).

Microbiological surveys have shown the presence of a variety of foodborne pathogens in sprouts. *Salmonella* species, *Listeria monocytogenes*, *Staphylococcus aureus*, *Bacillus cereus,* and *Aeromonas hydrophila* have been isolated from sprout seeds including alfalfa, mung, cress, and mustard (5). *Klebsiella pneumoniae* was also isolated from sprouts and seeds (8).

Sprouts follow a complex path from farm-to-fork that includes growing, harvesting, processing, and shipping of seeds, followed by sprouting and distribution of the finished product (6). There are several opportunities for the contamination of seeds or sprouts at any one of these points in production and distribution. Such contamination can be introduced in sprouts via a number of pathways including seeds, irrigation water used for sprouting, unsanitary production practices, or mishandling by consumers. However, epidemiological investigations suggest that seeds are the likely source in most sprout-associated outbreaks (5).

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Contamination of Seed During Growth and Harvesting

The exact mechanism by which seeds become contaminated with bacterial pathogens is not known. However, alfalfa and other types of seeds intended for sprouting are considered raw agricultural commodities and could therefore be exposed to a variety of potential sources of fecal contamination (4, 6). One such possibility is the use of fecally contaminated water to irrigate the seeds in the field (9). The use of raw or inadequately treated animal manure as fertilizer is another likely source of contamination during the growth of seeds (5, 6, 9, 10). Both *Salmonella* and *E. coli* O157: H7 could be introduced via this source. Occasionally, the fields are located near to animal rearing facilities. Manure stored on such facilities could seep unto the fields and contaminate the growing sprout seeds. Domestic animals are even allowed to graze on alfalfa fields before and after harvesting (5). Birds, reptiles, rodents, and other wild animals may also play a role in seed contamination in the field.

Harvesting procedures expose the seeds to a substantial amount of dirt and debris and likely spread localized contaminants throughout the harvested seeds (5). In most instances, only a small amount of this seed goes into sprout manufacturing, as a substantial portion may be used to produce forage for animal feed (5, 6). The decision to direct such seeds to agriculture or sprouting is usually made after harvest, thus there is little incentive to follow Good Agricultural Practices during growth and harvest. Worker hygiene during harvesting, storage, and distribution must be given serious consideration (5, 9, 10). Once present on seeds, pathogens are likely to survive for extended periods of time. Studies have shown that *Salmonella* can survive for months under dry conditions, such as those used to store alfalfa sprouts (5, 10). Seed processing, shipping, and selling practices often involve mixing multiple lots of seeds of different origin. This practice complicates trace-back and increases the risks of cross contamination of such seeds.

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Sprouts Production

Many of the sources of contamination of seeds during growth and harvesting could also be present at the sprouting facility. However, the key aspect of sprouting that allows sprouts to pose a special risk compared to other fresh produce, is the exponential growth of bacteria during the sprouting process (5, 6). Environmental, nutritional, and enzymatic factors are among those that have been identified that contribute to this rapid proliferation of bacteria on the germinating sprouts.

Sprout seeds have high levels of trypsin inhibitors, which may provide a defence mechanism by which seeds inhibit the trypsin-like enzymes in bacteria (1). However, these levels of trypsin inhibitors decrease during germination thereby enabling the microbial flora to proliferate. Similarly, the 10-fold increase in nutrients in the germinating seeds, over dry seeds, provides available substrates for microbial growth during sprouting. Additionally, the high levels of available moisture and the warmth generated from the sprouting process create a favourable environment for bacterial growth. These excellent conditions for bacterial growth are further facilitated by the fact that the sprouting process has no inherent kill steps that either prevent bacterial growth or eliminate them entirely (5). Hence the bacterial flora of sprouts were often two to ten logs higher than that observed in seeds (1, 7). *E coli* O157:H7 inoculated onto alfalfa seeds was shown to reach 10^6 to 10^7 cfu/g within 48 hours after the sprouting process began (11). Additionally, low levels of *Salmonella species* seeded into alfalfa seeds have been shown to increase by as much as four to five log in germinating sprouts (1). Therefore, the contamination of seeds with a few pathogens can potentially be amplified by the sprouting process and become a microbiological hazard.

Investigations of sprout-associated foodborne disease outbreaks have commonly failed to isolate the outbreak pathogen from the seeds while such organisms were occasionally isolated from the sprouts (5, 6, 10, 12, 13, 14, 15). This non-isolation from the seeds might tend to suggest that the seeds were not the source of the original contamination, but the possible reasons for such non-isolation include undetectable low levels of pathogens in the seeds and unequal distribution within seed lots. A reported study found that microbial population on commercial sprouts was very similar to that germinated in the laboratory under aseptic conditions (5). That study concluded that the bacterial species found on sprouts most likely originated from the seeds rather than from sanitary conditions of commercial sprouting processes. Similarly, in Finland an alfalfa sprout associated outbreak ended only after the industrial sprouting of alfalfa seeds was prohibited (12). This provides additional evidence that seeds are the likely source of contamination. Furthermore, inspection of sprouting facilities during outbreak investigations in the U. S. found no noteworthy violations (10, 15).

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Sprout -Associated Outbreaks

There are several pathogens that have either been implicated in sprout-associated outbreaks or that have been identified as being a potential source of increased risk due to their ability to proliferate during sprouting (5). These include *Salmonella,* Enterohemorrhagic *E coli, Bacillus cereus, Listeria monocytogenes, Yersinia enterocolitica and Shigella species.* However, only *Salmonella* and Enterohemorrhagic *E coli* O157 : H7 have consistently been linked with sprout -associated outbreaks.

Bacillus cereus is a spore forming bacteria that can be found in plants and soils. In 1973 this organism was linked to one of the first sprout-associated outbreaks (1, 6). Home-sprouting kits imported into the U. S. from Switzerland had a mixture of soy, mustard and cress seeds that were contaminated with *B cereus* either in pure culture or as a minor part of the flora. After germination, all the sprouts contained large numbers of the organism (6).

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Salmonella

The first of several sprout-related *Salmonella* outbreaks was reported from the United Kingdom in 1988 (1, 6). Raw mung bean sprouts were epidemiologically implicated as the cause of that *Salmonella saint-paul* outbreak that resulted in 143 reported cases. This outbreak was followed by another in 1989 in England and Wales, caused by *Salmonella* Gold -Coast resulting from eating mustard cress sprouts (6). In 1994, sprouts were again implicated in a large *Salmonella* bovismorbificans outbreak which resulted in 282 cases in Sweden and 210 in Finland (1, 6, 12). Both outbreaks were associated with the consumption of alfalfa sprouts grown from seeds imported from Australia (6, 16).

The first reported sprout-associated *Salmonella* outbreak in the U. S. occurred in mid -1995 as a part of an international outbreak involving 17 US states and Finland (6, 11, 12). The outbreak was linked to alfalfa sprouts contaminated with *Salmonella stanley*. The sprouts that caused the outbreaks in both countries were produced by many different sprouters, but the seeds were obtained from the same shipper in the Netherlands. Independent epidemiological studies of the outbreak conducted in Michigan, Arizona, and Finland found that consumption of sprouts was the only exposure significantly associated with illness (17). Furthermore, *S stanley* isolates from both American and Finnish patients had a unique DNA profile and antibiotic resistance pattern that was different from other *S stanley* strains (1, 17). These findings strongly suggest that alfalfa sprouts grown from contaminated seeds were the cause of this international outbreak. A total of 242 cases were reported for both countries, but based on under-reporting rates for *Salmonella* outbreaks, the actual number of cases was probably between 5,000 -24,000 (1).

In January 1996, public health officials in British Columbia and Oregon independently noted marked increases in reported *Salmonella enterica* serotype Newport cases (18). Co-ordinated epidemiological investigations implicated alfalfa sprouts produced from seeds shipped from the same Dutch firm implicated in the *Salmonella stanley* outbreak that occurred earlier that same year. A total of 133 cases were involved. A retrospective study identified a large previously unexplained increase in *Salmonella* Newport infections in 6 central and eastern U. S. states in fall 1995 (5, 18). Further investigations revealed that this was a protracted outbreak that was originally noted in Denmark in June 1995, caused by contaminated sprouts from the same shipper. It is estimated that as many as 20,000 persons were infected during the period that these seeds were likely to have been sprouted and eaten (18).

The largest sprout-associated outbreak in the U. S. occurred in California in June 1996

(6, 18). Over 450 cases occurred from the consumption of alfalfa sprouts contaminated with *Salmonella* Montevideo and Meleagridis resulting in the death of one elderly person from sepsis (5). Unsatisfactory sprouting practices and sub-optimal employee hygiene were identified as the cause of the contamination. At the farm where the seeds were grown, chicken manure was used to fertilize the field before planting, horses grazed in adjacent fields, and animal manure was stored next to alfalfa fields (5, 6).

Consumption of contaminated alfalfa sprouts was associated with outbreaks of *Salmonella infantis* and *Salmonella anatum* from April to June 1997 in Kansas and Missouri (5, 6). Seeds were again epidemiologically determined to be the source of the outbreaks. In October 1997, an outbreak of *Salmonella* Meleagridis which affected 78 persons in Alberta, Canada was linked to eating alfalfa sprouts (5, 6). The outbreak serotype was isolated from sprouts at the retail level. Alfalfa and clover sprouts mixture was associated with two clusters of *Salmonella* Senftenberg infections in Northern California in late 1997 through June 1998 (5, 6).

A cluster of cases in Arizona and California in May, 1998 was linked to eating alfalfa sprouts contaminated with *Salmonella* Havana. Sprouts produced from that same lot of seeds were implicated in an outbreak of *Salmonella* Cubana from May to September 1998 in Arizona, California, New Mexico, Maryland and Utah (5, 6).

At least four clover or alfalfa sprout-associated outbreaks occurred from January through May 1999 affecting approximately 200 persons in Idaho, Oregon, Washington, California and Colorado (19). This includes an outbreak of *Salmonella* Mbandaka affecting approximately 75 persons in four states from January to March(5). The last reported US outbreak was in August 1999, affecting 19 persons in Wisconsin. There were reports of sprout-related *Salmonella* illness in western Canada in mid-to-late 1999 (20).

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E coli O157: H7.

The world's largest reported outbreak of *E coli* O157: H7 infection was a sprout -associated outbreak in Japan in 1996 (11, 14). White radish sprouts from a single farm were epidemiologically linked to the over 6,000 cases, most of whom were school children. Of these cases, 153 required hospitalization and there was one death (21). In March 1997, a cluster of 96 cases was again linked to the consumption of radish sprouts in that country (22).

In June and July 1997, simultaneous outbreaks of *E coli* O157: H7 infection in Michigan and Virginia were independently associated with eating alfalfa sprouts grown from the same seed lot (11, 15). Molecular sub-typing of isolates from both states by PFGE demonstrated that the outbreaks were linked by a common strain. The simultaneous occurrence of two geographically distinct outbreaks linked to the same lot of seeds and caused by the same strain of *E coli* strongly suggest that contaminated seeds were the source.

In June 1998, a non-motile strain of *E coli* O157 resulted in 8 culture positive cases in Nevada and California (11, 18). Alfalfa / clover mixture, from the same sprout producer implicated in the *S senftenberg* outbreak, was associated with this outbreak

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Reducing Microbial Hazard on Sprouts

It has been demonstrated that even a few pathogenic cells on seeds can become a health hazard through rapid proliferation during the sprouting process. It is therefore essential that steps be taken to prevent the initial contamination of seeds or to eliminate any pathogenic organisms present, preferably before sprouting. Prevention or intervention steps may be taken at any one or more points during sprout production. Interventions include strategies that target seed during growth,

harvesting and distribution; sprouts during sprouting and germination; and the finished product (5). Procedures to prevent contamination, chemical and physical treatments to reduce or eliminate contamination, microbial testing, or a combination of more than one method are some of the strategies explored.

There is relatively little scientific literature available pertaining to the reduction or elimination of pathogenic bacteria on seeds or sprouts during growth (5). A substantial amount of research however, has been focusing on prevention and intervention technologies to eliminate pathogens from seeds prior to sprouting.

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Seed Production, Storage and Transportation

Efforts should be made to reduce the potential for seed contamination during growing, harvesting, conditioning, storage, and transportation. These risks can be reduced by applying the principles of Good Agricultural Practices for fruits and vegetables as outlined by the U. S. Food and Drug Administration (23). The requirements for water, manure, worker health, sanitary facility, field sanitation, transportation and trace-back are provided in this document. Part 2 of the Canadian Food Inspection Agency's (CFIA) Code of Practice for Minimally Processed Foods also outlines requirements for Good Agricultural Practices, and although not specific to sprouts, remains relevant (24). Additional recommendations on seed conditioning, storage and transportation are provided in the FDA's Guide for the sprout industry (25).

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Chemical Treatment

Several studies have been done to determine the effectiveness of a wide range of chemicals in killing pathogenic bacteria on seed sprouts and seeds intended for sprout production. Some of these were done specifically for *Salmonella* (26, 27), *E coli* O157: H7 (11, 13, 28), and *Klebsiella pneumoniae* (8). Chemicals used in such studies, at different concentrations, exposure times and temperatures, include: calcium hypochlorite, sodium hypochlorite, hydrogen peroxide, ethanol, and ozone. Although most of the studies reported substantial reductions in the specific pathogens studied, none of the treatment methods were able to completely eliminate such organisms. Even if only a few organisms survive a seed treatment, they can grow to high levels during sprouting and contaminate the entire batch (25). Therefore, disinfection alone can not be relied upon to ensure the safety of sprouts. The best results were obtained with the use of calcium hypochlorite; thus approval was granted for its use at 20, 000 ppm (25).

It has been suggested that the barrier to disinfecting seeds is not in the lethality of the treatment solutions but, the inability of treatments to reach pathogens in the seeds

(5, 27). Microbial cells in seed crevices and between the cotyledons and testa may be protected from exposure to lethal concentrations of sanitizers.

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Heat Treatment

Application of heat to kill pathogens on alfalfa seeds has been investigated (26) in a study that found treatment at 57 or 60 degrees C for 5 minutes appeared to be effective in killing *S stanley* without substantially decreasing germinability of seeds. However, heat treatment has limited appeal because there is such a fine threshold at which bacteria can be killed and germination not destroyed (4).

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Use of Gamma Radiation

Research carried out by the U. S. Department of Agriculture concluded that treating alfalfa seeds and sprouts with a combination of chlorine and irradiation effectively safeguards them against contamination by *E coli* O157: H7 and *Salmonella* (29). The report further stated that the doses used to eliminate those organisms did not affect germination of seeds. However, the required irradiation dose is higher than the 1.0 kiloGray dose allowed for fruits and vegetables. Further studies are required to confirm these preliminary reports.

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Use of HACCP Principles and Good Manufacturing Practices

The Hazard Analysis Critical Control Points (HACCP) system is a risk reduction technique to control food safety hazards and provide safer food products for consumers . HACCP focuses on identifying and preventing hazards at each operational point in a food process rather than depending on spot checks of production processes and random sampling of finished products (4). HACCP provides a more structured and critical approach to the control of identified hazards than that achievable by traditional inspection and quality control procedures. International Sprout Growers Association (ISGA) members are required to follow sanitation methods approved by the FDA including HACCP standards and Good Manufacturing Practices . A HACCP checklist was developed by the ISGA for the use of its members (30).

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Competitive Exclusion

Competitive exclusion techniques, where non-pathogenic micro-organisms are used to repress the growth of pathogens during sprouting have been suggested (5). However, there is very little literature available on the topic.

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Finished Product

There are few studies on reducing the pathogen levels in finished products. Due to their fragility, sprouts cannot withstand abrasive physical washing (29). Furthermore, washing mature sprouts with water reduced *Salmonella* and *E coli* O157: H7 by no more than 1 log (5). Gamma radiation is a possibility, but again the required dose exceeds current allowable limit.

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New FDA Guidelines

Despite the efforts by industry, government agencies, and academia to make sprouts safer, outbreaks continued to occur. It was therefore obvious that approved treatments, such as the routine use of seed disinfection treatments with 20,000 ppm of calcium hypochlorite, could not guarantee a safe product. This resulted in the FDA issuing new guidelines for the sprouting industry in October 1999 (25, 31).

The sprout guidance (25) identifies a number of areas, from the farm to the sprouting facility, where FDA believes immediate steps should be taken to reduce the risk of sprout-associated foodborne illness. Specific recommendations in the guide include: development and implementation of Good Agricultural Practices and Good Manufacturing Practices in production and handling of seeds and sprouts; seed disinfection treatment; microbial testing before the product enters the food supply; and provision for trace-back. The guide recommends that seeds should be subjected to one or more treatments that have been approved for reduction of pathogens on seeds and sprouts. This is to be followed by microbial testing of the spent irrigation water from each production lot to ensure that any contaminated batch is not distributed. Test results can be obtained as early as 48 hours and since the growing period is usually three to ten days producers can obtain results before shipping products. The second document outlines the detailed procedures to be followed in implementing the testing (31).

Reports from the ISGA indicate that several growers are complying with these new guidelines (personal communication with ISGA executive member, Barbera Sanderson, Feb.2000)

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Food Safety Risk Communication

Consumer confidence in food safety is decreasing, and there is a public perception that there is more risk to human health from foods now than ever before. Recent food scares, amplified by media coverage, have increased consumers' perceived risks and decreased demand for certain products (32). Therefore, in today's climate of intense and sustained media and consumer interest in food safety issues, food scientist, regulatory authorities, and the industry often need to communicate both proactively and reactively with consumers about food safety risks (33).

Risk communication is a process within risk analysis that includes an open exchange of information and opinion leading to a better understanding of risks and risk-related decisions. Like all other forms of communications, risk communication should be a multi-directional process which facilitates an interactive process of exchange of information and opinion. Such exchange among interested parties must provide information on the nature, magnitude, significance, or control of a risk (34).

Information about risk can be communicated through a variety of channels, ranging from media reports and warning labels to public meetings and hearings, involving representatives from government agencies, industry, the scientific community, the media, and the general public (34). Consumers have a right to information about food safety issues and occasionally events reported in the media become the substantial basis for the public framing of risks relating to such issues (35, 36).

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Risk Communication and Sprouts

The importance of sprouts as a significant source of foodborne illness was first recognized in North America following the mid -1995 sprout-associated *Salmonella stanley* outbreak (1, 6). That outbreak heralded the start of media interest in sprouts as a food safety risk. The Edmonton Journal was the first Canadian paper to report on the outbreak (37).

One of the first risk communication releases from the authorities in North America relating to the consumption of sprouts was a press release from the Oregon Health Division on February 8, 1996 about the *Salmonella newport* outbreak in Oregon and British Columbia (38, 39). The release stated that the implicated product was voluntarily recalled by the distributor and consumers were encouraged to discard sprouts with the implicated labels, purchased within a specific time period. It outlined the major symptoms of salmonellosis and stated that there was an increased risk of severe illness in individuals such as the very young, pregnant women, the elderly, and the immuno-compromised. Those high-risk groups were warned that they should be aware of what was described as the low risk associated with the consumption of sprouts.

A detailed report, of the investigation and management of the outbreak was provided in the Oregon Health Division's CD Summary on February 20, 1996 (40). This is a bi-weekly bulletin produced by the Health Division and mailed out to physicians, medical laboratories, Public Health Departments, major media and other interested parties. The report stated that co-ordinated news releases were issued in Oregon and British Columbia on the same date. There was some amount of coverage in Canada, but the release in Oregon coincided with widespread flooding that dominated the news in that state. News about the outbreak in Oregon was therefore virtually buried.

Once the press decides to cover a topic it becomes news, and if the subject has enough substance, and sustains reader interest, it remains in the news (41). This seemed to be the case with sprouts as the press continued to report on that outbreak, providing updated information on the investigation, and reminding consumers, especially vulnerable groups, to be aware of the risks associated with eating sprouts (42-44). The dropping of sprouts from the menu of a company with over 1,000 cafeterias across Canada, due to the *Salmonella* scare in British Columbia and Oregon, was also in the news (45, 46). The *Salmonella* Saint Paul outbreak in Northern California in June 1996, due to the consumption of clover sprouts was similarly reported (47).

Health Canada did not issue a warning about sprouts, during that period, as an official of that agency reportedly stated that there was thought to be no nationwide risk of *Salmonella* infection (46). There was no report of any *Salmonella* case linked to sprouts in eastern Canada during that period.

Scientific journals also carried a fair amount of coverage on sprouts and sprout-associated outbreaks during that period, including the enormous sprout-associated *E. coli* O157: H7 outbreak in Japan (12, 16, 21, 26). One of those journal articles was the report of a study conducted at the University of Georgia that concluded that common methods of treating seeds used for sprouting may not kill *Salmonella* (26). The sprouting environment, which facilitated the growth of *Salmonella*, was said to be a serious public health concern requiring urgent attention, due to the association with sprouts and foodborne illness. The researchers stressed that the result was not a recommendation for people to avoid sprouts at salad bars, but served as a wake-up call for those who produced and prepared the product.

The study determined that chlorine was able to reduce the amount of *Salmonella* in the seeds. In response, the FDA released a recommendation that alfalfa seeds being used for sprouting should be treated with 500-2,000 ppm of chlorine for 30 minutes, followed by a wash with water containing 3ppm of free chlorine (26). Consumers and sections of the industry that were opposed to the use of chlorine were told that the choice they had was between an organic process that did not include chlorine and a higher risk of foodborne illness.

Information on sprouts continued in news reports in 1997, commencing with a California Health Department consumer health warning against the consumption of Fuji Natural Foods label alfalfa sprouts (48). The big news during that period, however, was the sprout-associated outbreak of *E. coli* O157:H7 in Michigan and Virginia from June to July of that year (49-53). That was the first documented association of alfalfa sprouts and *E coli* O157:H7 infection and the first association of sprouts and that pathogen in the U. S.

The Centers for Disease Control and Prevention (CDC) in its 1997 report on the outbreak recommended that persons at high risk for severe complications from *E coli* O157:H7 and *Salmonella* infections could reduce their risk by not eating sprouts (50). That was the first recommendation from an organization to any group not to eat sprouts. Later that year, the Canadian Food Inspection Agency issued a health alert to the public not to consume alfalfa sprouts or any mix of alfalfa sprouts bearing Living Foods, Sunsprout Natural Foods, and Sprouts Alive labels (54, 55). The alert stated that the young, elderly, and immuno-compromised were particularly at risk.

On August 31, 1998, one year after the CDC warning, the FDA, in a press release, issued an interim advisory on alfalfa sprouts (56, 57). It served to reaffirm previous health advisories that persons who were at high risk for severe foodborne illness should avoid eating raw alfalfa sprouts. The advisory was said to be an interim measure until such time as intervention methods were in place to improve the safety of the product. The California Department of Health Services had earlier issued a statewide advisory about the potential risk of illness to vulnerable populations from the consumption of raw sprouts. Alfalfa sprouts was only the third food item in the FDA's recent effort to single out the millions of vulnerable persons in the population needing special warnings (57). The advisory stated that the International Sprout Growers Association was taking positive steps to address the problem, such as pursuing the use of calcium hypochlorite at 20,000 ppm. However, there was some amount of doubt as to the industry's ability to manage the problem. At least one newspaper stated that the industry was aware of the problem but did not know how to fix it (58). Additionally, one consumer group said that the FDA should also require warning labels on packages of sprouts sold at fresh produce counters, grocery stores, and supermarkets (56). It was thought that such mandatory warning labels would be a more systematic way of warning consumers.

As a follow-up to the advisory the FDA held a two-day public meeting with industry groups, the academics, and the general public to discuss ways to ensure the safety of sprouts. Through that avenue, consumers had an opportunity to voice their ideas about what had become an important public health issue. A report in the later part of the year stated that the National Advisory Committee on Microbial Criteria for Foods would be proposing a range of measures to combat the growth of pathogens in all production stages of sprouts (59).

The findings of a Committee that was established to investigate the 1995 sprout-associated outbreaks in the U. S. and Canada were published in January 1999 (18). That report was carried by several media outlets (60-66). Additionally, it was discussed on the CBC News and Current Affairs talk show program on the eve of the publication. The panellists included one of the members of that Committee.

The researchers reported that the source of the problem was contaminated seeds used to produce the sprouts. Those seeds were from a single batch distributed by a wholesaler in Europe, however the original source was not identified. The authors concluded that sprouting methods that were being used were inadequate to protect against *Salmonella* and that sprouts was an inherent and high-risk source of *Salmonella* infection.

However, the industry reported that growers were using chlorination process approved by the Environmental Protection Agency for seed decontamination (61). The president of the International Sprouts Growers Association however, was reported as stating that the Committee's report preceded new methods for safeguarding seeds and although the old techniques did not work, the new ones would (61, 65). In contrast, one sprout producer in British Columbia was reported as stating that the publicity did not hurt his business and might even help to weed out bad seed suppliers and sprouters (66).

In Canada some public health professionals and government researchers were reported to be in favour of irradiation of sprouts, especially alfalfa sprouts (66). If approved, sprouts would become one of Canada's first irradiated food. However, at least one sprouter felt that irradiation was a controversial treatment that would ruin the public image of sprouts as a healthy fresh food (66). One senior British Columbia public health official reportedly stated that people should be more open to the subject of irradiation. However, no report was found of any attempts being made to obtain public opinion on that matter.

The CFIA's position on the consumption of sprouts, at that time, was different from the approach in the U. S. At a time when public health officials, including some in Canada, were warning about the risks associated with the consumption of sprouts, a CFIA official was reportedly stating that its consumption was just as hazardous as eating several other foods (66). High risk groups were advised by that official, according to the report, to stay away from all foods that may carry harmful pathogens, but sprouts was said to be a safe commodity for normal healthy adults.

Due to the increasing concerns about the risks associated with sprouts, a Sprouts Task Force which included the FDA, ISGA, EPA, USDA, the Illinois Institute of Technology, and the Universities of Georgia and Massachusetts was established (67). Its goal was to identify techniques to reduce the number of pathogens in sprouts by more than 99.9 per cent. The options considered to achieve that goal included heat treatment of seeds prior to sprouting, chemical disinfection of seeds followed by testing, and two different methods of irradiation. Even though the industry was predicted to loose as much as $50 million in 1999, due to reduced sales, the president of the ISGA was reported as stating that the organization felt that the health of consumers was the most important priority. The organization was therefore anxious to find ways to rid sprouts of pathogens and restore consumer confidence in the product.

The increasing number of sprout-associated illness resulted in a release issued by the FDA on July 9, 1999, advising all persons to be aware of the risks associated with eating raw sprouts (19). That advisory was updated from the one issued in 1998 and was based on additional information from sprout-associated *Salmonella* outbreaks from January through May 1999. The report stated that in spite of the co-ordinated efforts to enhance the safety of sprouts, there were continued reports of illness associated with consumption of the raw product. Consumers were informed that they needed to understand that at that time the best way to control the risk was not to eat raw sprouts. Additional consumer advice provided in the advisory included the cooking of sprouts and specifically requesting that raw sprouts should not be added to foods at restaurants and delis. The FDA stated that it would monitor the situation and take any further actions required to protect consumers. Detailed accounts of the advisory were carried by the media (68-70).

In Canada, a media report stated that Health Canada was not prepared to go as far as its U. S. counterpart (71). According to the report, although admitting that Canadian consumers could not tell if sprouts at the local grocery are safe, a Health Canada official stated that there was a minimal risk for some people in the population. That official reportedly stated that high-risk populations should avoid eating sprouts but everyone else was probably safe. Anyone that was worried about their sprouts should probably cook them, according to the Health Canada official. That media report gave the impression that the U. S. warning was a panic reaction and further stated that it had stunted sprouts sales in Canada. According to the report, one Canadian organic sprouts producer stated that sprouts was less a worry than all the chemicals farmers put on their crops to fight weed and bugs. Another sprouts farmer reportedly stated that the risk from sprouts was probably better than risks associated with other foods such as eggs and meats, and that Canadian consumers had nothing to fear since all the sprouts sold in Canada were grown there. A member of the academia was however quick to respond to that media article pointing out, among other things, that the actions by the FDA and the efforts of the U. S. sprouts industry should be praised rather than being decreed as panic (72).

A health hazard alert was issued by the CFIA to the public on July 14, the same day on which the article describing the U. S. actions as a panic reaction was published, warning against the consumption of Living Foods and Sprouts Alive brands of alfalfa sprouts from a specific lot (73). The products were believed to be contaminated with *Klebsiella pneumoniae* organisms. However, rather than giving precise instructions, the alert stated that consumers who had concerns about the products should discard them or return them to their points of purchase. Such statements are likely to give the impression that only consumers who have concerns should not consume the product. The alert was carried by the press, mainly in Western Canada (74-76).

Although the products were voluntarily recalled, the company maintained that they were safe to eat as long as consumers were not immuno-compromised. The company expressed fears of the long-term impact of the warning and was even thinking of what legal actions it could take against the CFIA. It was of the opinion that *Klebsiella pneumoniae* was not a pathogen and that the requirements for testing were changed by the CFIA without consultation with the industry. This was a vast contrast to the situation in the U. S. where the agencies and the industry were working together to reduce the risks and the industry itself accepting some amount of responsibility and showing concern for consumers safety.

Another health hazard alert was issued by the CFIA two months later warning the public not to eat Living Foods and Sprouts Alive brand alfalfa and deli sprouts because they may contain *Salmonella* organisms (20).

Consumers were warned by Colorado health officials to either cook sprouts or avoid them (77). The owner of 14 natural foods supermarkets went even further by announcing that he would voluntarily post sprouts advisory in the fresh produce sections of his stores. At that same time agriculture officials in Wisconsin recommended that grocery stores should not sell sprouts, restaurants should not serve them, and people should not eat them (78-81).

On October 25, 1999 the FDA issued two new guidance documents to enhance the safety of sprouts (23, 25, 81, 82). The guidance provided advice to be taken by sprouts producers and seed suppliers to reduce microbial hazard common to sprouts production. It was stated that although the FDA would solicit public comments, the guidelines were being implemented immediately because of the seriousness of the public health hazard associated with sprouts.

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Conclusion

Seed sprouts gained their popularity as a health food and this resulted in an increased demand for sprouts. However, sprouts have also emerged as a significant source of foodborne illness, due to their association with outbreaks of *Salmonella* and *E. coli* O157: H7. Treatment of seeds with chemicals such as 20, 000 ppm calcium hypochlorite can not guarantee that the product will be safe. The authorities in the U. S. therefore found it necessary to declare raw sprouts a high-risk food for all consumers since avoidance was seen as the best way to reduce the risk of infection.

In keeping with the notion that consumers should be informed about risks associated with food products, there was a conscious effort by the regulatory authorities, particularly in the U. S. to communicate the risks associated with sprouts to the public. Press releases and national health hazard alerts were the methods most commonly used. The media was very supportive in the effort through widespread coverage of those releases and the provision of information relating to actions that can be taken by the public to reduce the risk of infection. Public meetings were also held to provide information and to give the public an opportunity to participate in policy decisions. The industry in the U. S. acted prudently, making public statements expressing concern for consumer safety and the desire to identify techniques to ensure the safety of sprouts and restore consumer confidence.

In Canada, the approach by industry and government were in some respects different from those in the U. S. Warnings were restricted to health hazard alerts when a problem or potential problem was identified with a specific lot of the product. Additionally, there seemed to be a lack of understanding and co-operation between the industry and the CFIA, unlike the situation with the FDA and the ISGA in the U. S.

The effectiveness of the risk communication strategies used is unclear as in spite of such widespread coverage, there were still reports of spout-associated outbreaks. In the future, it might be useful to explore other strategies such as mandatory warning labels on individual packages offered for sale at retail outlets.

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