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Opinions of Provincial Food Safety Specialists on Addressing Canadian Beef Processing Risks

ABSTRACT

Outbreaks associated with microbial pathogens in the Canadian beef industry have raised awareness regarding pathogen dissemination throughout the farm-to-fork continuum. Canadian beef processing represents a conjoined effort by federally-licensed and provincially-licensed processing establishments. Although federal facilities must adhere to rigorous standards because of the large-scale distribution of beef, they do not necessarily correlate with the standards of provincial facilities, which are governed by provincial regulatory bodies. This could lead to discrepancies in regulation and perceptions of risk between provinces.

Six meat safety experts from the Ministries of Agriculture or Health from five Canadian provinces were interviewed about risks, risk mitigation strategies, and limitations within these strategies throughout all stages of beef production. The most commonly identified risk was temperature abuse, identified by all five provinces. Existing policy and regulation, along with proper inspection and standardized procedures, served as dominant factors in

mitigating risks. The experts also identified a variety of limitations within the current mitigation strategies, including a lack of standardized procedures within and between provinces, the absence of HACCP requirements, and lack of frequent inspection. Based on these accounts, it is concluded that provincial processing facilities require additional efforts (e.g., enhanced inspection, continual training, greater information sharing) to streamline current risk mitigation practices.

INTRODUCTION

Beef represents approximately 10% of Canada's Agri-food exports, and Canada was the world's seventh largest exporter of beef in 2014 (1). Approximately 82, 240 farms and ranches house 11.92 million beef cattle nationally, with approximately 41% of this total bred in Alberta (1). Notably, Canada produces approximately \$9.8 billion Canadian dollars (CAD) worth of beef products annually, considerably more than the pork (\$3.4 billion CAD) and chicken (\$2.4 billion CAD) industries' annual revenues (1, 2). On the other hand, beef products have also been implicated in a greater

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number of recalls in Canada than pork and chicken combined (8). Concerns over pathogenic microorganisms caused the Canadian Food Inspection Agency (CFIA) to issue 66 recalls for beef products between 2012 and 2015, compared to four and 12 for pork and chicken, respectively (10). Given that beef is a high-risk commodity and represents a substantial proportion of Canada's food production, here we focus on risk-based aspects pertaining exclusively to beef processing and discuss issues that revolve predominantly around cattle.

Production of beef in Canada is regulated through multiple levels of legislation, which govern many aspects within the farm-to-fork continuum, including animal husbandry, slaughter, processing and retail (28). The Canadian beef processing industry is divided into federal and provincial processing establishments, which encompass abattoirs (i.e., slaughterhouses) and downstream processing facilities (i.e., for production of intact beef cuts and ready-to-eat meat products). Federal and provincial processing establishments are governed by their respective separate authorities (28); federally-registered facilities are governed by the CFIA, whereas provincial or territorial governments are responsible for regulation of provincially-registered facilities. Laws governing these two types of facilities may also differ; for instance, federally-registered facilities are subject to all rules and regulations laid out by the federal *Meat Inspection Act* whereas provincially-registered facilities may or may not have provincial regulation.

On a national level, the meat products produced by large-scale, federally registered facilities may be distributed between provinces for consumption or for export to the global market, and represent 95% of the total meat produced in Canada. In contrast, small to medium sized provincially registered facilities produce the remaining 5%, which may be distributed only within the province (8).

Recent high-profile beef safety issues have drawn increased public awareness and emphasized potential food safety protection limitations within the Canadian beef processing sector. In particular, the 2012 *Escherichia coli* O157:H7 outbreak (27) highlighted food safety concerns within Canadian beef production. It was later revealed that inadequate inspection of the processing facility and inadequate training of inspectors were contributing factors in this outbreak (21). Moreover, the 19th bovine spongiform encephalopathy (BSE) case in Canada was reported in 2015, which resulted in beef trade restrictions to six countries: Korea, Taiwan, Peru, Belarus, China and Indonesia, although spread to humans or to other cattle was not documented (7).

Partly because of stringent Hazard Analysis Critical Control Point (HACCP) regimens, the federally regulated beef sector has earned Canada an overall reputation of producing safe, high-quality beef (28). HACCP constitutes a control system with the aim of identifying hazards and performing intervention strategies to reduce the likelihood for these hazards to occur. Critical control points, steps

at which controls may be applied to eliminate or reduce a particular hazard, are identified through HACCP. In beef processing specifically, critical control points include the stages of stunning, evisceration, carcass washing, packaging and shipping (5). These HACCP protocols have been extended through much of the "farm-to-fork" meat-processing continuum, although, as evidenced from pathogen outbreaks, they do not always guarantee risk-free outcomes. In provincially regulated facilities, full HACCP programs are not mandatory; instead, long-established visual inspections may still be practiced to meet food safety regulatory requirements (17, 25), with microbial testing taking place only in extraordinary instances, such as upon the occurrence of a process deficiency (e.g., batch contamination) (28). Regulatory agencies and legislation governing the beef industry, therefore, may also vary among provinces (Tables 1 and 2). A shift has been seen in some provinces, such as Ontario, towards developing HACCP-like processes (i.e., founded on HACCP principles) at the provincial level (28). However, the overall food safety management practices in provincially regulated facilities across Canada remain largely unknown because of a lack of information sharing. Moreover, province-specific trends in risk management remain unclear. To further clarify these factors, five Canadian provinces responsible for the greatest beef production were studied: British Columbia (possessing approximately 203,000 head of cattle housed in 33 provincial processing facilities), Ontario (268,000 in 96 facilities), Manitoba (459,000 in 26 facilities), Saskatchewan (1.1 million in 89 facilities) and Alberta (1.5 million in 43 facilities) (6, 14, 15, 26, 31). Focusing on the top five beef-producing provinces in Canada, this report aimed to identify the following in provincially licensed beef processing facilities along the farm-to-fork continuum: (i) the perceived risk factors leading to microbial dissemination along the food chain; (ii) the current risk mitigation strategies (e.g., legislation, procedures currently in practice); and (iii) the presence of disparities or knowledge limitations within the current risk mitigation strategies.

MATERIALS AND METHODS

Identification and recruitment

We used in-depth key informant interviews to explore risks, mitigation strategies, and gaps associated with food safety in different provinces across Canada (20). Qualitative methodology necessitates a small sample size, which facilitates a greater depth of knowledge development than can be achieved with a broader survey method. The key informant interviews provided a detailed examination of policies, processes and regulations, as well as a discussion of practical issues related to implementation and risk, that would not have been possible from a national survey of policy makers.

Experts from five of the six provinces contacted participated in this study. Respondents based in the Ministries of Agriculture from Nova Scotia and Saskatchewan both

TABLE 1. Responsibilities and roles in beef safety regulation by province

Province	Public health agencies responsible for meat safety regulation	Third party certifications	Collaborations
Alberta	<ul style="list-style-type: none"> • CFIA¹ • Alberta Agriculture and Rural Development (MIB²) • Alberta Health Services 	<ul style="list-style-type: none"> • Gov't⁶: none • Industry: dependent on retailers (i.e., organic certification audit for organic produce retailers) 	Occasional case basis: <ul style="list-style-type: none"> • Western Meat Inspection Committee (outside province) • Alberta Health Services
British Columbia	<ul style="list-style-type: none"> • BC MoA³ • BC MoH⁴ 	<ul style="list-style-type: none"> • Gov't: none • Industry: dependent on retailers 	Occasional case basis: <ul style="list-style-type: none"> • BC health authorities • BCCDC • MoAs outside of the province
Manitoba	<ul style="list-style-type: none"> • CFIA • MAFRD⁵ • Manitoba Health 	<ul style="list-style-type: none"> • Gov't: none • Industry: <ul style="list-style-type: none"> • "HACCP advantage" • Food safety initiatives 	Regular practice/occasional basis/emergencies: <ul style="list-style-type: none"> • CFIA (within province) • Manitoba Health
Ontario	<ul style="list-style-type: none"> • CFIA • MoH & Long-term Care 	<ul style="list-style-type: none"> • Gov't: rare • Industry: dependent on retailers 	Regular practice/occasional basis/emergencies: <ul style="list-style-type: none"> • CFIA • FDA⁷ • Public health agencies • ON public health units
Saskatchewan	<ul style="list-style-type: none"> • CFIA • MoA • Local regional health authorities 	<ul style="list-style-type: none"> • Gov't: The Sanitation Regulations under <i>The Public Health Act, 1994</i> • Industry: none 	Regular practice/occasional basis/emergencies: <ul style="list-style-type: none"> • SK Food Industry Development Centre • CFIA (within & outside province) • MoA and MoH (within & outside province)

¹CFIA: Canadian Food Inspection Agency

²MIB: Meat Inspection Branch (now under the Food Safety Branch of Alberta Agriculture and Forestry)

³MoA: Ministry of Agriculture

⁴MoH: Ministry of Health

⁵MAFRD: Manitoba Agriculture, Food and Rural Development

⁶Gov't: Government

⁷FDA: Food and Drug Administration

declined our invitation, but Saskatchewan referred us to a respondent in the Ministry of Health. The professional roles of the experts included food safety specialist, coordinator, consultant, and manager of operations or audit programs based in the Provincial Ministries of Agriculture or Health.

The following provinces, along with the number of informants in each province, were recruited: Alberta [AB] (1), British Columbia [BC] (2), Manitoba [MB] (1), Ontario [ON] (1) and Saskatchewan [SK] (1). These

provinces constituted the top five beef-producing provinces (32) and reflected diversity in province size, scale of meat production, and regulatory frameworks. Potential respondents were identified through: (i) search for meat/food safety specialists on websites of provincial Ministry of Agriculture (MoA) or Ministry of Health (MoH); and (ii) research team contacts and snowball sampling. Invitations were subsequently extended to potential respondents by E-mail.

Questionnaire and interview process

Respondents participated in a 1–2 hour audio-recorded structured telephone interview. The questionnaire included demographic information and questions about responsibilities and roles in meat safety regulation at the provincial level. It was designed to collect detailed information about (i) oversight and legislation, (ii) risks and mitigation strategies, (iii) gaps in risk mitigation, and (iv) current or planned risk mitigation strategies. This information was collected for all stages of the meat production continuum from farm to fork: pre-harvest (i.e., animal husbandry, feed, transport); slaughter; post-slaughter processing (i.e., processing of intact cut meat, ready-to-eat (RTE) food production and storage, finished product transport; and post-processing (i.e., retail, foodservice industry, home preparation and consumption) stages. At each stage, risks were characterized using a matrix based on the likelihood of occurrence and consequences of an event. An interview guide was provided in advance of the telephone interview to facilitate access to detailed information during the discussion. The study was approved by the UBC Behavioral Research Ethics Board (Certificate# H14-01820), and all the interviewees provided written informed consent.

Analysis of data

To describe risk perception during the different beef processing stages, risk levels were constructed by using a risk matrix accounting for consequences of the event and likelihood of occurrence (30). The most important risk factors and their respective risk mitigation strategies pertaining to each of the four stages of meat production (pre-harvest, slaughter, processing, post-processing), as identified by the meat processing experts, were compiled. We report on risk factors that have either a high likelihood and/or consequence level or that were mentioned by at least three of the six informants. It should be noted that the expertise of the informants varied based on their professional role. In particular, the respondent from SK did not comment on the risk-based aspects of some meat processing stages because of the jurisdiction being separate from that of the SK MoA.

Using answers given by the respondents, similarities, dissimilarities and trends between provinces regarding beef processing aspects were noted and discussed further. Similar answers given by respondents from different provinces were grouped together, while different answers given by different provinces were presented separately. As two respondents were interviewed from BC, their answers were compiled to illustrate an overall provincial perspective. Draft data summary tables were shared with the interviewees to provide an opportunity for them to address data gaps and correct any errors.

RESULTS

Six respondents from five Canadian provinces were interviewed for the present study. An overview of the

oversight of meat production and processing in each province is presented in *Table 1*.

The most important risk factors and their respective risk mitigation strategies pertaining to each of the four stages of meat production (pre-harvest, slaughter, processing, post-processing), as identified by the meat processing experts, are presented here. The risk factors identified by at least three of the six informants are presented and further discussed.

Pre-slaughter

The three main risks identified by the experts in the pre-slaughter stage were: (i) inadequate training of personnel; (ii) poor animal health; and (iii) the presence of specified risk material (SRM).

Effective training of facility personnel is essential to limiting the spread of zoonotic disease agents (e.g., pathogenic *E. coli*). Elements of effective training include the understanding of each employee's designated role(s) within the production of safe beef products and thorough comprehension of established critical control points and associated control measures (12). In some instances, certificates or permits must be obtained before operations are carried out (e.g., transport of specified risk materials require CFIA-registered permits). Effective training, therefore, will subsequently ensure the appropriate execution of HACCP and minimal-risk operations (30). Based on these principles, inadequate training may be considered as a failure in the education and/or execution with regard to adequate control measures.

The respondent from AB highlighted inadequate training of personnel, specifically in the live animal storage stage prior to slaughter. This risk was of high priority (medium likelihood, high consequence), but the respondent indicated that proper oversight would be adequate in mitigating this risk. AB noted that this risk could be further reduced through various extension services provided by the Government of Alberta, which would assist with provision of funds for training programs. In contrast, none of the other provinces indicated lack of training of personnel at the pre-slaughter stage as a risk factor. AB also indicated that one of the primary knowledge gaps was different inspection responsibilities for handlers (i.e., pre-slaughter stage) and processors (i.e., slaughter stage). It was recommended that routine gap assessments be put into place by provincial bodies to fully address the lack of standardization and that multiple representatives from federal and provincial authorities have roles in provincial inspection.

Poor animal health was another primary risk highlighted during the stages of animal husbandry [AB][BC][MB][ON] and live animal transport [AB][MB][ON]. Poor animal health can increase the risk for zoonotic disease transmission and constitutes a significant risk for food safety if sick animals are not separated from healthy animals. For instance, milk and soft cheeses contaminated with *Listeria monocytogenes*

have been traced back to cattle showing outward disease symptoms of listeriosis (24). Further, *Salmonella* serovars recovered from diseased cattle in Michigan was responsible for an increase in the incidences of human salmonellosis (16). Risk assessments ranged from low to medium, and there was no consensus on perceptions of severity regarding this risk. However, respondents indicated similar mitigation strategies; inspections [AB][ON] and on-farm food safety programs [MB] were deemed to be efficacious in mitigating this risk at both pre-slaughter stages. In addition, the voluntary Verified Beef Production program, delivered across Canada by the Canadian Cattlemen's Association, helps establish essential standard operating procedures for proper management practices (e.g., animal health management, responsible antibiotic usage, personnel training) and performs third-party validation audits to ensure continued success. The goal of this program is to promote and ensure consistently safe and high quality beef products (22).

In terms of province-specific risk mitigation strategies, ON indicated the presence of emergency management programs to manage animal health issues arising on-farm, an initiative led by the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA). AB also identified the usage of provincially-licensed mobile butchers, which perform the slaughter of animals on-farm; use of these butchers could potentially avoid the negative impacts of transporting animals, which could otherwise promote or exacerbate disease (15). However, meat slaughtered by a mobile butcher must be identified as “uninspected — not for sale” and is available for consumption only by the producer and immediate household, unless ante mortem inspections take place (5). This initiative is also in effect in British Columbia and the Yukon (5). No gaps were identified in the current processes to mitigate poor animal health.

SRM constitutes a sizeable risk because of the potential for the spread of Bovine Spongiform Encephalopathy (BSE), or “mad cow disease,” from infected to healthy cattle. According to the Canadian *Health of Animals Act* (2015): “specified risk material (SRM) means the skull, brain, trigeminal ganglia, eyes, tonsils, spinal cord and dorsal root ganglia of cattle aged 30 months or older.” One of the potential routes of transmission for SRM is in animal feed, as noted by AB and BC. The consequence of this risk was perceived at drastically different levels; AB noted that the consequence of contamination was high while BC perceived this as low. In Canada, animal feed is strictly regulated by the federal government (Table 2); therefore, federally-established SRM removal programs and protocols are the primary means of mitigating the likelihood of SRM contamination, which was indicated by both AB and BC. The respondents also did not identify gaps in the current processes to mitigate SRM contamination of animal feed, likely because of stringent federal control measures.

Slaughter

All respondents identified mishandling of SRM during slaughter as the dominant risk factor leading to downstream dissemination of pathogenic microorganisms. Any deviation from standardized procedures for handling (i.e., identification, removal and destruction) of SRM may be considered non-compliance.

It is well recognized that improper slaughter is a leading risk factor for contamination of carcasses (13, 31), although strict legislation has defined the proper dressing and removal procedures of SRM during slaughter (Table 2). Although all respondents identified improper SRM handling as a risk factor, their individual risk perceptions varied; AB was the sole province to perceive this as a high risk factor, whereas other provinces perceived this as ranging from low to moderate, likely due to differences in relative proportions of the beef industries within their provincial economy. To address this risk, experts have recommended several strategies: on-farm food safety programs [AB][MB], ante/post mortem inspections [BC][ON], adequate sanitation [ON][SK], visual inspections [BC][MB], regulations [AB], government-funded extension services [AB], education and training of personnel [BC] and proper plant management [BC]. With the exception of ON, the respondents identified the following gaps in risk mitigation: a lack of policy in regulation of sanitation schemes [SK], a lack of training for inspectors and staff [BC][MB], the absence of oversight for Class D and E facilities (i.e., licensed on-farm slaughter facilities where product sales are restricted to the region of slaughter) [BC] and a lack of standardization in the procedures for handling of SRM [AB]. Both AB and MB called for a standardization of meat safety regulatory requirements in their respective provinces. Efforts to develop legislation leading to enhanced practices have been seen; BC indicated that provincial strategies have focused primarily on the industry level, including the development of standardized procedures for those facilities allowing on-farm slaughter (e.g., Class D and E facilities in BC), continual training, and the integration of the Regional District North Okanagan (RDNO) project, which seeks to enhance the resiliency of rural agricultural sites by providing essential services (e.g., food safety workshops) (29). AB and MB noted their provincial strategies revolved mainly around developing new legislation, including a joint effort of industry and provincial agencies to develop enhanced policies [AB], and the development of industry requirements for better documentation during slaughter and downstream processing [MB].

Post-slaughter processing

The respondents identified two predominant risks associated with post-slaughter processing: mishandling and temperature abuse, both of which could exacerbate the likelihood or severity of microbial contamination (19).

Mishandling of carcass products was cited by all respondents, though the likelihood and consequences ranged from low to high among the different provinces. It has been shown that during post-slaughter processing the best strategy for minimizing microbial risk is to prevent contamination of the carcass with microbial pathogens (31). Commonly mentioned mitigation strategies to reduce the likelihood of improper handling include policy and regulations [AB][BC][ON][SK] and, in some cases, risk-based inspection programs [ON][SK]. Specifically, for RTE food production, AB cited specific training requirements for staff, on-site monitoring, and extension services (i.e., to fund training programs) as mitigating strategies. Because of the nature of ready-to-eat meat products, personnel should be trained to carry out specific control measures that differ from those used for non ready-to-eat meat products; for instance, RTE products should undergo a minimum amount of thermal lethality prior to distribution (9). Personnel should also be trained in post-lethality procedures of RTE products (e.g., high pressure processing) for prevention of pathogen growth and extension of shelf life (9). Additionally, on-site monitoring should reproducibly verify the absence of pathogenic microorganisms even in worst-case scenarios (e.g., the coldest regions in the food product) (9). Notably, MB noted the lack of mitigation strategies associated with this processing stage.

Current gaps mentioned by experts included a lack of oversight and/or frequency of inspections [BC][SK] as well as a lack of frequent product testing for RTE foods [AB]. AB also highlighted a regulatory discrepancy: meat processing facilities are licensed and inspected by the Meat Inspection Branch of Alberta Agriculture and Forestry, whereas freestanding facilities, or those not involved in animal slaughter, are licensed and inspected by Alberta Health Services (Table 1) (3). This discrepancy was also highlighted by AB for abattoirs. Of particular concern for MB when it came to post-slaughter processing was the lack of requirement for a HACCP program at non-federally registered plants to circumvent the likelihood of microbial contamination, though it was suggested that HACCP requirements would be introduced in the future. Future strategies mentioned by the respondents included ongoing discussions between government and industry to design surveillance programs more in line with federal standards [AB], as well as the requirement of documented food safety procedures in [BC]. BC also mentioned that increased food safety training through the BC Centre for Disease Control (BCCDC) may be an additional way to reduce gaps and risks in this area.

Temperature abuse during storage and transport was cited by all five respondents as another important risk factor, though the level of perceived risk varied from very low to high. Current mitigation strategies described by the respondents include inspectional oversight, audit programs [AB][ON], and documented food safety plans [BC].

Direct operator training [MB][SK] and the use of guidance documents such as brochures and pamphlets to inform operators of safety standards [BC] were also identified. No major gaps were cited for storage, but several were discussed in reference to transport. For instance, in AB two regulatory bodies monitor transport, one during transportation and one at distribution receiving. Also mentioned was difficulty in regulating and enforcing transport [BC][ON], especially where transporters are not licensed [MB]. Interestingly, concerns over differences in federal and provincial temperature requirements were further discussed [BC]. Ongoing strategies to address these gaps include discussions between industry and government committees to develop clearer standards based on existing regulations [AB], as well as introduction of regulatory requirements for larger transportation vehicles [MB]. Also suggested was the introduction and use of stickers able to detect temperature abuse [MB].

Post-processing

The two primary concerns mentioned in this area were (i) temperature abuse (also previously identified as a major risk in post-slaughter processing) and (ii) microbial cross-contamination as a result of poor handling practices.

As with post-slaughter processing, temperature abuse was again cited by all respondents as a major concern during post-processing in retail sales, foodservice industry, and home preparation, although perceived risk varied across the different respondents. Risk mitigation strategies generally fall under regulation and oversight [AB][BC][ON]. However, operator training [MB][SK] and the use of food safety programs [MB] were also mentioned; food safety programs and/or education would be the only strategy able to mitigate the risk at the home preparation stage. A few specific concerns were also addressed in relation to the food service industry in BC: a lack of resources for inspection and oversight in rural areas, and the fact that the regulation of retail counters at slaughter houses falls under the jurisdiction of both the Ministry of Agriculture and Ministry of Health. One suggested future mitigation strategy was the requirement of legislated food safety training for all workers along the slaughter to distribution continuum [MB]. No specific gaps were mentioned in respect to retail services such as grocery stores. It should be noted, however, that some respondents were unable to comment on gaps in this area was due to it being out of their jurisdiction.

Another concern mentioned was the risk of microbial cross-contamination in the areas of retail sales [MB][SK] and home preparation and consumption [BC][MB][ON][SK], primarily due to improper handling. MB and SK both suggested increased operator training, while MB also mentioned the presence of food safety programs as a mitigating factor in the retail sector. BC, MB, ON and SK agreed that making educational resources readily available

TABLE 2. Farm-to-fork oversight and legislation of beef safety by province

Stage	Relevant legislation	Agencies responsible for policy and guidelines	Inspection responsibility
Animal husbandry	Federal legislation • <i>Health of Animals Act</i> [AB][BC][ON]	SPCA ¹ [AB][BC][ON]; MoA ⁶ , Other non-profit organizations [BC]; CFIA, OMAFRA ⁴ [ON]	Animal Health Branch [AB]; CFIA [AB][ON]; SPCA [BC][ON]; OMAFRA [ON]
	• <i>Criminal Code of Canada</i> [ON]	CFIA, SPCA, OMAFRA [ON]	CFIA, SPCA, OMAFRA [ON]
	• <i>Food and Drug Act</i> [ON]	CFIA, SPCA, OMAFRA [ON]	CFIA, SPCA, OMAFRA [ON]
	• <i>Dairy Act</i> [MB]	MAFRD [MB]	Agri-food inspectors, Animal protection officers [MB]
	Provincial legislation • <i>Animal Protection Act</i> [AB]	CFIA, SPCA [AB]	CFIA, Animal health branch [AB]
	• <i>Prevention of Cruelty to Animals Act</i> [BC]	SPCA, Other non-profit organizations [BC]	SPCA [BC]
	• <i>Animal Care Act</i> [MB]	MAFRD [MB]	Agri-food inspectors, Animal protection officers [MB]
	• <i>Livestock and Livestock Products Act</i> [MB]	MAFRD [MB]	Agri-food inspectors, Animal protection officers [MB]
	• <i>Livestock Medicines Act</i> [ON]	CFIA, SPCA, OMAFRA [ON]	CFIA, SPCA, OMAFRA [ON]
	• <i>Veterinarian's Act</i> [ON]	CFIA, SPCA, OMAFRA [ON]	CFIA, SPCA, OMAFRA [ON]
• N/A [SK]	N/A [SK]	N/A [SK]	
Animal feed	Federal legislation • <i>Health of Animals Act</i> [AB]	CFIA [AB]	CFIA, MIB ⁹ (AB)
	• <i>Feeds Act</i> [ON]	CFIA [ON]	CFIA [ON]
	Provincial legislation • No provincial legislation [BC][MB]	N/A [BC][MB]	N/A [BC][MB]
	Other • Unaware [SK]	N/A [SK]	N/A [SK]
Live animal transport	Federal legislation • <i>Health of Animals Act</i> [AB][BC][MB][ON]	CFIA [AB][BC][MB][ON]	CFIA [AB][BC][MB][ON]; Provincial agencies [AB]; OMAFRA [ON]
	Provincial legislation • Animal Protection Regulations (within Health Regulations) [AB]	CFIA [AB]	CFIA [AB] Provincial agencies [AB]
	Other • N/A [SK]	N/A [SK]	N/A [SK]
Live animal storage pre-slaughter	Federal legislation • Meat Inspection Regulation [AB][BC]	CFIA [AB][BC][MB]	CFIA [AB][BC][MB]
	• <i>Meat Inspection Act</i> [MB]	MIB [AB]; Meat Inspection Program, MoA [BC]; MAFRD [MB]	MIB [AB]; Meat Inspection Program, MoA [BC]; Provincial meat inspectors [MB]
	• <i>Public Health Act</i> [MB]	CFIA; MAFRD [MB]	CFIA, Provincial meat inspectors [MB]

(Continued on next page)

TABLE 2. Farm-to-fork oversight and legislation of beef safety by province (cont.)

Live animal storage pre-slaughter	<ul style="list-style-type: none"> • <i>Health of Animals Act</i> [ON] 	CFIA, AAFC ² [ON]	CFIA, OMAFRA [ON]
	Provincial legislation <ul style="list-style-type: none"> • <i>Livestock Community Sales Act</i> [ON] 	CFIA, AAFC [ON]	CFIA, OMAFRA [ON]
	<ul style="list-style-type: none"> • <i>Food Safety and Quality Act</i> [ON] 	CFIA, AAFC [ON]	CFIA, OMAFRA [ON]
	<ul style="list-style-type: none"> • <i>OSPCA⁵ Act</i> [ON] 	CFIA, AAFC [ON]	CFIA, OMAFRA [ON]
	Other <ul style="list-style-type: none"> • N/A [SK] 	N/A [SK]	N/A [SK]
Slaughter	Federal legislation <ul style="list-style-type: none"> • <i>Meat Inspection Act</i> [AB][MB] 	CFIA [AB][MB]; MIB [AB]; MAFRD [MB]	CFIA [AB][MB]; MIB [AB]; Provincial meat inspectors [MB]
	<ul style="list-style-type: none"> • <i>Public Health Act</i> [MB] 	CFIA, MAFRD [MB]	CFIA, Provincial meat inspectors [MB]
	<ul style="list-style-type: none"> • The Sanitation Regulations (under the <i>Public Health Act, 1994</i>) [SK] 	MoH, ⁷ Regional health authorities [SK]	Regional health authorities [SK]
	Provincial legislation <ul style="list-style-type: none"> • Meat Inspection Regulation (under the <i>Food Safety Act</i>) [BC] 	Meat Inspection Program [BC]	Meat Inspection Program, MoA [BC]
	<ul style="list-style-type: none"> • <i>Food Safety and Quality Act</i> [ON] 	OMAFRA [ON]	OMAFRA [ON]
Processing (cutting, deboning, grinding, etc.)	Federal legislation <ul style="list-style-type: none"> • <i>Meat Inspection Act and Regulations</i> [AB][BC][MB] 	Alberta Health Services, MIB [AB], CFIA [AB] [MB]; MoH, Regional health authorities [BC]; MAFRD, Manitoba Health [MB]	CFIA [AB][MB]; MIB, Alberta Health Services [AB]; Regional health authorities [BC]; Manitoba Health, MAFRD [MB]
	<ul style="list-style-type: none"> • <i>Public Health Act</i> [AB][BC][MB] 	Alberta Health Services [AB]	CFIA [AB][MB]
	<ul style="list-style-type: none"> • Food Safety Regulation (under The <i>Public Health Act, 1994</i>) [SK] 	MIB [AB]; CFIA [AB] [MB]; MoH [BC][SK] Regional health authorities [BC]; MAFRD, Manitoba Health [MB]	MIB, Alberta Health Services [AB]; Regional health authorities [BC][SK]; Manitoba Health, MAFRD [MB]
	Provincial legislation <ul style="list-style-type: none"> • Food Premise Regulation [BC] 	MoH, Regional health authorities [BC]	Regional health authorities [BC]
	<ul style="list-style-type: none"> • <i>Food Safety and Quality Act</i> [BC][ON] 	CFIA, OMAFRA, AAFC [ON]; MoH, Regional health authorities [BC]	OMAFRA [ON]; Regional health authorities [BC]
	<ul style="list-style-type: none"> • <i>Food and Drug Act</i> [ON] 	CFIA, OMAFRA, AAFC [ON]	OMAFRA [ON]
	<ul style="list-style-type: none"> • <i>HPPA³</i> [ON] 	CFIA, OMAFRA, AAFC [ON]	OMAFRA [ON]
Production of RTE products	Federal legislation <ul style="list-style-type: none"> • <i>Meat Inspection Act and Regulations</i> [AB][BC][MB] 	Alberta Health Services, MIB [AB]; CFIA [AB] [MB]; MoH [BC]; Regional health authorities [BC]; MAFRD, Manitoba Health [MB]	CFIA [AB][MB]; MIB, Alberta Health Services [AB]; Regional health authorities [BC]; Manitoba Health, MAFRD [MB]
	<ul style="list-style-type: none"> • <i>Public Health Act</i> [AB][BC][MB] 	Alberta Health Services [AB]	CFIA [AB][MB]

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TABLE 2. Farm-to-fork oversight and legislation of beef safety by province (cont.)

Production of RTE products	<ul style="list-style-type: none"> Food Safety Regulation (under The <i>Public Health Act, 1994</i>) [SK] 	MIB [AB]; CFIA [AB] [MB]; MoH [BC][SK]; Regional health authorities [BC]; MAFRD, Manitoba Health [MB]	MIB, Alberta Health Services [AB]; Regional health authorities [BC][SK]; Manitoba Health, MAFRD [MB]
	<ul style="list-style-type: none"> <i>Listeria</i> policy [ON] 	CFIA, OMAFRA [ON]	CFIA, OMAFRA [ON]
	<ul style="list-style-type: none"> <i>Safe Food for Canadians Act</i> [AB] 	Alberta Health Services, CFIA, MIB [AB]	Alberta Health Services, CFIA, MIB [AB]
	Provincial legislation <ul style="list-style-type: none"> Food Premise Regulation [BC] 	MoH, Provincial health authorities [BC]	Regional health authorities [BC]
	<ul style="list-style-type: none"> <i>Food Safety and Quality Act</i> [BC] [ON] 	MoH, Provincial health authorities [BC]; CFIA, OMAFRA [ON]	Regional health authorities [BC]; CFIA, OMAFRA [ON]
Finished product storage	Federal legislation <ul style="list-style-type: none"> <i>Meat Inspection Act</i> and Regulations [AB] 	Alberta Health Services [AB] MIB, CFIA [AB]	Alberta Health Services [AB] MIB, CFIA [AB]
	<ul style="list-style-type: none"> <i>Public Health Act</i> [AB][BC][MB] 	Alberta Health Services [AB]	CFIA [AB][MB]
	<ul style="list-style-type: none"> Food Safety Regulation (under The <i>Public Health Act, 1994</i>) [SK] 	MIB [AB]; CFIA [AB] [MB]; MoH [BC][SK]; Regional health authorities [BC]; MAFRD, Manitoba Health [MB]	MIB [AB]; Alberta Health Services [AB]; Regional health authorities [BC][SK]; Manitoba Health, MAFRD [MB]
	Provincial legislation <ul style="list-style-type: none"> Food Premise Regulation [BC] 	Regional health authorities [BC]	Regional health authorities [BC]
	<ul style="list-style-type: none"> <i>Food Safety and Quality Act</i> [BC][ON] 	Regional health authorities [BC]; OMHLTC ^s , OMAFRA [ON]	Regional health authorities [BC]; OMAFRA, Federal public health inspectors [ON]
Finished product transport	Federal legislation <ul style="list-style-type: none"> <i>Meat Inspection Act</i> and Regulations (AB) 	MIB, Alberta Health Services, CFIA (AB)	MIB, Alberta Health Services, CFIA (AB)
	<ul style="list-style-type: none"> <i>Public Health Act</i> [AB][BC][MB] 	Alberta Health Services [AB]	CFIA [AB][MB]
	<ul style="list-style-type: none"> Food Safety Regulation (under <i>The Public Health Act, 1994</i> and <i>The Traffic Safety Act</i>) [SK] 	MIB [AB]; CFIA [AB] [MB]; MoH [BC][SK]; Regional health authorities [BC]; MAFRD, Manitoba Health [MB]; Highway Traffic Board officials [SK]	MIB, Alberta Health Services [AB]; Regional health authorities [BC][SK]; Manitoba Health, MAFRD [MB]; Highway traffic officers [SK]
	Provincial legislation <ul style="list-style-type: none"> Food Premise Regulation [BC] 	Regional health authorities [BC]	Regional health authorities [BC]
	<ul style="list-style-type: none"> <i>Food Safety and Quality Act</i> [BC][ON] 	Regional health authorities [BC]; OMHLTC, OMAFRA [ON]	Regional health authorities [BC]; OMAFRA, Federal public health inspectors [ON]
	<ul style="list-style-type: none"> <i>HPPA</i> [ON] 	OMHLTC, OMAFRA [ON]	OMAFRA, Federal public health inspectors [ON]
Retail sales	Federal legislation <ul style="list-style-type: none"> Food and Drug Regulations [BC] 	MoH, Regional health authorities [BC]	Regional health authorities [BC]
	<ul style="list-style-type: none"> <i>Public Health Act</i> [AB][BC][MB] 	Alberta Health Services [AB]	CFIA [AB][MB]

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TABLE 2. Farm-to-fork oversight and legislation of beef safety by province (cont.)

Retail sales	<ul style="list-style-type: none"> Food Safety Regulation (under <i>The Public Health Act, 1994</i>) [SK] 	MIB [AB]; CFIA [AB] [MB]; MoH [BC][SK]; Regional health authorities [BC][SK]; MAFRD, Manitoba Health [MB]	MIB, Alberta Health Services [AB]; Regional health authorities [BC][SK]; Manitoba Health, MAFRD [MB]
	Provincial legislation <ul style="list-style-type: none"> Food Premise Regulation [BC] 	Regional health authorities [BC]	Regional health authorities [BC]
	<ul style="list-style-type: none"> <i>Food Safety Act</i> [BC] 	MoH, Regional health authorities [BC]	Regional health authorities [BC]
	<ul style="list-style-type: none"> <i>HPPA</i> [ON] 	OMHLTC, OMAFRA [ON]	OMAFRA, Federal public health inspectors [ON]
Foodservice industry	Federal legislation <ul style="list-style-type: none"> Food and Drug Regulation [BC] 	MoH, Regional health authorities [BC]	Regional health authorities [BC]
	<ul style="list-style-type: none"> <i>Public Health Act</i> [AB][BC][MB] 	Alberta Health Services [AB]	CFIA [AB][MB]
	<ul style="list-style-type: none"> Food Safety Regulation (under <i>The Public Health Act, 1994</i>) [SK] 	MIB [AB]; CFIA [AB] [MB]; MoH [BC][SK]; Regional health authorities [BC][SK]; MAFRD, Manitoba Health [MB]	MIB, Alberta Health Services [AB]; Regional health authorities [BC][SK]; Manitoba Health, MAFRD [MB]
	Provincial legislation <ul style="list-style-type: none"> Food Premise Regulation [BC] 	Regional health authorities [BC]	Regional health authorities [BC]
	<ul style="list-style-type: none"> <i>Food Safety Act</i> [BC] 	MoH; Regional health authorities [BC]	Regional health authorities [BC]
	<ul style="list-style-type: none"> <i>HPPA</i> [ON] 	OMHLTC, OMAFRA [ON]	OMAFRA, Federal public health inspectors [ON]
Home preparation & consumption	Federal legislation <ul style="list-style-type: none"> <i>Public Health Act</i> [AB] 	Alberta Health Services [AB]	Alberta Health Services [AB]
	<ul style="list-style-type: none"> Food and Drug Regulation [BC] 	CFIA [BC]	CFIA [BC]
	<ul style="list-style-type: none"> <i>Consumer Packaging and Labeling Act</i> [MB] 	CFIA [MB]	CFIA [MB]
	<ul style="list-style-type: none"> <i>Meat Inspection Act</i> [MB] 	CFIA [MB]	CFIA [MB]
	Provincial legislation <ul style="list-style-type: none"> <i>HPPA</i> [ON] 	OMHLTC [ON]	Public health inspectors [ON]
	Other <ul style="list-style-type: none"> N/A [SK] 	N/A [SK]	N/A [SK]

¹SPCA: Society for the Prevention of Cruelty to Animals

²AAFC: Agriculture and Agri-Food Canada

³HPPA: Health Protection and Promotion Act

⁴OMAFRA: Ontario Ministry of Agriculture, Food and Rural Affairs

⁵OSPCA: Ontario Society for the Prevention of Cruelty to Animals

⁶MoA: Ministry of Agriculture

⁷MoH: Ministry of Health

⁸OMHLTC: Ontario Ministry of Health and Long-Term Care

⁹MIB: Meat Inspection Branch (now under the Food Safety Branch of Alberta Agriculture and Forestry)

to consumers was an essential mitigation strategy for minimizing the risk of microbial cross-contamination in household kitchens. No major gaps in mitigation practices pertaining to this risk in the retail sector were identified; although the respondents agreed there were many gaps in the current risk reduction strategies at the home preparation stage. In particular, there is an overwhelming lack of consumer understanding of food safety [BC][SK], no assumption of responsibility for consumer education, with heavy reliance on industry to fulfill this aim [MB] and a lack of understanding of the most effective means for consumer education [ON]. However, ON mentioned utilization of creative means (i.e. social media, brochures) to fulfill this aim.

DISCUSSION

Beef processing in Canada represents a multi-faceted, collaborative effort overseen by provincial and federal facilities. Because of the pre-destined streams in which beef undergoes processing, provincial and federal processing plants differ in their regulatory requirements. In contrast to federal facilities, provincial meat processing facilities are primarily governed by the authorities within the province of distribution, and these requirements may not necessarily correlate with federal standards.

The goal of this study was to elucidate expert perceptions of risks within “farm-to-fork” meat processing between provinces, as well as to identify current risk mitigation practices and limitations within these practices. In particular, limitations of this study included: (i) the small number of respondents we were able to recruit, which led to the exclusion of information from some provinces, especially in Atlantic Canada; (ii) the small number of respondents with expertise in their respective province’s beef production processes; and (iii) interview time constraints (one to two h). In future work, it would be beneficial to interview a larger subset of respondents from multiple jurisdictions (e.g., MoA and MoH) provincially to gain more representative perceptions of provincial beef production. Further, respondents directly interacting with retail/food service and consumers (e.g., food inspectors, public health educators) may be able to provide a more accurate view of risks toward the end of the farm-to-fork continuum.

Each province identified pertinent risks as potentially detrimental to meat processing within their respective provinces. It was evident that in no instance was any respondent completely satisfied with all risk mitigation strategies in their respective province. Of particular concern was the absence of risk mitigation strategies in some provinces — BC (retail sales) and MB (RTE processing) — despite the associated risk perceptions. Further, provinces identified and perceived risks differently and cited risk mitigation strategies and disparities differently, suggesting that provincially-licensed facilities in Canada vary in their modes of operation and oversight. For instance, AB perceived

risks to be of higher consequence than other provinces, even when the same risk was identified, likely due to the economic importance of beef production in Alberta (1). Further, AB repeatedly identified the presence of multiple regulatory agencies playing a role in oversight (Table 1) and noted that this dual presence partially accounted for the lack of standardized practice within the meat processing industry in AB. This lack of standardization would be mediated by harmonizing facility oversight across the multiple agencies involved. On the other hand, BC and MB indicated their concerns over lack of inspections and the lack of HACCP requirements, respectively. Increasing factors such as the frequency and quality of inspections may help with reducing food safety risks. Interestingly, ON identified very few disparities with ON’s mitigation strategies, citing adequate oversight of all food safety aspects by provincial programs (e.g., emergency management programs) already established.

Overall, the major risks identified across the provinces related to animal health, SRM, transportation and storage of diseased animals, microbial contamination, and temperature abuse (Table 3). The respondents also emphasized the following recurring disparities present in the provincial risk mitigation strategies: a lack of standardization due to shared responsibilities between federal and provincial jurisdictions [AB], the absence of HACCP requirements for provincially-licensed facilities [MB], a lack of inspection and/or oversight [BC][SK], and knowledge limitations of environmental health officers [BC], highlighting prominent deficiencies to be addressed in the current provincial risk reduction tactics. ON did not identify the presence of a recurring disparity across the farm-to-fork processing continuum.

Efforts to address high priority risks must be executed by all stakeholders involved in the farm-to-fork continuum, including all tiers of government, departments, and agencies. In brief, focusing on such high-priority areas and gaps within the current risk mitigation strategies (Table 3) at each stage of the continuum will inevitably lead to positive change in current efforts. In particular, greater attempts to increase the health and welfare of animals, while minimizing the dissemination of zoonotic disease agents, might be achieved through enhanced inspection efforts and continual training for all parties directly involved with processing. Additionally, clarifying roles between all parties involved in oversight of operations would lead to the prompt development and implementation of new policies. This may further assist with standardization of current and future policies, leading to the establishment of consistent practices in provincial processing facilities across Canada. Further, facilitation of information sharing would enable enhanced coordination of all stakeholders involved and encourage the timely identification and rectification of process deficiencies, as well as better anticipation and control of future problems that could arise. Such shared information should include the reporting of factors such as: (i) substantial process deficiencies/non-compliances that may compromise

TABLE 3. Risks most frequently identified by the meat safety experts by processing stage

Processing stage	Most frequently identified risk	Mitigation strategies used	Gaps identified
Animal husbandry	Poor animal health [AB][BC][MB][ON]	<ul style="list-style-type: none"> • None [AB] • Application guides for farmers [BC] • On-farm food safety programs [MB] • Veterinary inspections [ON] • Emergency management programs [ON] 	<ul style="list-style-type: none"> • Lack of training for rural slaughter licensing [BC] • Lack of inspection without complaints [BC] • Lack of incentive to implement better practices [MB] • None [ON]
Animal feed	Contamination of feed with SRM [AB][BC]	<ul style="list-style-type: none"> • SRM removal programs and protocols [AB][BC] 	<ul style="list-style-type: none"> • None [AB][BC]
Live animal transport	Transportation of compromised animals [AB][MB][ON]	<ul style="list-style-type: none"> • Antemortem inspections [AB] • On-farm slaughter to avoid transportation (e.g., mobile butcher programs) [AB] • On-farm food safety programs [MB] • Veterinary inspections [ON] 	<ul style="list-style-type: none"> • None [AB][MB][ON]
Pre-slaughter storage	Storage of diseased animals [BC][ON]	<ul style="list-style-type: none"> • Monitoring and oversight through inspectors [BC] • Antemortem inspections [ON] 	<ul style="list-style-type: none"> • None [BC][ON]
Slaughter	Improper handling of SRM [AB][BC][SK][MB][ON]	<ul style="list-style-type: none"> • Extension services (AB) • On-farm food safety programs [AB][MB] • Education and training of personnel [BC] • Plant management [BC] • Visual inspections [BC][MB] • Ante/postmortem inspections [BC][ON] • Sanitation practices [ON][SK] 	<ul style="list-style-type: none"> • Gaps in the common industry standard of handling specified risk materials [AB] • No oversight or inspection for Class D or E facilities [BC] • Lack of training for inspectors and staff [BC][MB] • None [ON] • Sanitation regulations are out-dated, and updates will not include provisions for carcass inspection [SK]

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TABLE 3. Risks most frequently identified by the meat safety experts by processing stage (cont.)

Processing stage	Most frequently identified risk	Mitigation strategies used	Gaps identified
Processing	Microbial contamination [BC][SK][MB][ON]	<ul style="list-style-type: none"> • Constructional requirements (i.e., proper facility design to facilitate hygienic operations) [BC] • Food safety procedures [BC] • Regulations and policy [BC][ON][SK] • Few strategies in place – many gaps present [MB] • Risk-based inspection programs [ON][SK] 	<ul style="list-style-type: none"> • Knowledge limitations of environmental health officers [BC] • Lack of inspections and food safety plans [BC] • No requirements for HACCP plans [MB] • None [ON] • Lack of regulatory oversight of complex, high risk processing operations [SK]
Processing (RTE)	Microbial contamination [AB][BC][SK][MB][ON]	<ul style="list-style-type: none"> • Extension services [AB] • On-site monitoring [AB] • Training requirements for personnel [AB] • Regulations and policy [AB][BC][ON][SK] • Constructional requirements [BC] • Food safety procedures [BC] 	<ul style="list-style-type: none"> • Lack of frequency for product testing and monitoring [AB][BC] • Knowledge limitations of environmental health officers [BC] • No provincial program for risk mitigation [MB] • None [ON]
Finished product storage	Temperature abuse [AB][BC][SK][MB][ON]	<ul style="list-style-type: none"> • Risk-based inspection programs [ON][SK] • Few strategies in place – many gaps present [MB] • Inspectional oversight [AB][ON] • Food safety plans [BC] • Guidance documents (e.g., brochures, pamphlets) [BC] • Regulatory requirements [BC][MB][ON][SK] • Audit programs [ON] • Operator training [SK] 	<ul style="list-style-type: none"> • Regulatory oversight of complex, high risk processing operations [SK] • Lack of inspection [BC] • None [AB][SK][MB][ON]

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TABLE 3. Risks most frequently identified by the meat safety experts by processing stage (cont.)

Processing stage	Most frequently identified risk	Mitigation strategies used	Gaps identified
Finished product transport	Temperature abuse [AB][BC][SK][MB][ON]	<ul style="list-style-type: none"> • Inspectional oversight [AB][BC][ON] • Food safety plans [BC] • Guidance documents (e.g., brochures, pamphlets) [BC] • Regulatory requirements [BC][MB][ON][SK] • Operator training [MB] • Requirements for larger transportation vehicles [MB] • Use of stickers to detect temperature abuse [MB] • Audit programs [ON] • Frequent collaboration with Ministry of Health & public health units [ON] 	<ul style="list-style-type: none"> • Transport is monitored by separate provincial bodies (MIB and Alberta Health Services) [AB] • Differences between federal and provincial temperature requirements [BC] • Lack of understanding on how to best enforce and regulate transportation [BC][ON] • No licensing of transporters [MB] • None [SK]
Retail sales	Temperature abuse [AB][BC][SK][MB][ON]	<ul style="list-style-type: none"> • Inspectional oversight [AB][ON] • No mitigation strategies in place [BC] • Food safety programs [MB] • Operator training [MB][SK] • Regulatory requirements [ON][SK] 	None [AB][BC][MB][ON][SK]
Foodservice	Temperature abuse [BC][SK][MB][ON]	<ul style="list-style-type: none"> • Inspectional oversight [BC] • Regulatory requirements [BC][MB][ON] • Food safety programs [MB] • Operator training [MB] • Unaware [SK] 	<ul style="list-style-type: none"> • Limited resources and access for inspection of rural areas [BC] • Limited resources and access for inspection of rural areas [BC]
Home preparation	Microbial contamination [BC][SK][MB][ON]	<ul style="list-style-type: none"> • Educational resources ([BC][MB][ON][SK]) 	<ul style="list-style-type: none"> • Lack of consumer understanding of food safety practices [BC][SK] • No assumption of responsibility for consumer education [MB] • Lack of understanding on how to best educate consumers [ON]

the microbiological security of beef products produced; (ii) effective corrective actions for rectifying system failures; and (iii) any interesting observations that may be important to monitor for changes or unusual trends in regards to food safety implications.

Countries with a similar beef regulatory framework may benefit from the insights herein, particularly regarding risk perceptions and risk reduction strategies. Considering the globalization of food trade, international collaborative efforts will also be helpful to generate ideas for how to mitigate risks or fill outstanding knowledge or application gaps.

CONCLUSION

In the present study, risk-based aspects pertaining to provincial meat processing facilities across five provinces in Canada were assessed, although this was not an exhaustive list of all risk factors, mitigation strategies, and limitations. The diversity of insights and opinions shared by the various respondents emphasizes the mosaic of risk reduction strategies employed in provincially-licensed facilities across Canada. Overwhelmingly, the respondents described different limitations in their current mitigation systems, underlining the need for province-specific strategies to

address these inconsistencies. These insights from various provinces offered unique insights into beef production in Canada from a risk management perspective and enhance the current knowledge regarding provincial beef production schemes. To facilitate the development of enhanced food safety initiatives, it is essential that stakeholders be proactive and adopt approaches to address the current system deficiencies. In particular, risks and risk mitigation gaps assessed as high-risk and/or frequently identified across provinces should be emphasized when developing future policies, as these will be important for the improvement of provincial food safety in Canada.

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