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Sous Vide Cooking in Restaurants: A Qualitative Study of Ontario Public Health Inspector Knowledge, Experience, Practices and Needs

ABSTRACT

The use of the sous vide cooking method in restaurants outside Europe has grown in popularity over the past ten years. Whereas some jurisdictions have responded to the increased popularity of sous vide by releasing guidance documents or updating food codes to provide direction to restaurant operators and Public Health Inspectors (PHIs), the province of Ontario has not yet produced any sous vide resources or legislative updates. To determine if there is a need for sous vide resources in Ontario, a qualitative study was conducted, using a focus group and one-on-one, semi-structured interviews with PHIs who had encountered sous vide use in the field. Identification and enforcement emerged as predominant concerns among the PHIs, as well as the potential for the improper use of sous vide processes by restaurant operators. The data provided by the study participants suggest that sous vide use in restaurants is under-reported because of difficulties with its identification. The development and promotion of training resources for both PHIs and operators is recommended, followed by the creation of Ontario guidelines for safe sous vide cooking in restaurants. These findings and recommendations are likely applicable to many jurisdictions, both in and outside of Canada, where sous vide is a relatively new cooking method in local restaurants.

INTRODUCTION

Sous vide means "under vacuum" in French and is a method of cooking where food is vacuum sealed in plastic pouches and cooked in a water bath or steam oven at a specific temperature and time, often at lower temperatures and longer times than traditional cooking methods. While no confirmed outbreaks have been attributed to sous vide in the literature, many articles have been published about the risk of *Clostridium botulinum* growth in vacuum packaged foods, as well as the complexities of using low temperature-long time (LTLT) cooking to achieve pasteurization of hazardous foods *(1, 2, 14, 17, 27, 28)*. To mitigate these risks, each sous vide recipe must be assessed and validated to ensure food safety. Food processing industries have done this successfully for years through Hazard Analysis Critical Control Point

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(HACCP) based programs. The concern lies more with the recent growth in popularity of sous vide cooking in restaurants, where food safety knowledge and control plans can vary widely and existing legislation may be inadequate.

Food safety concerns

Sous vide recipes that are validated to provide adequate reductions in vegetative pathogens rarely result in a sufficient reduction of pathogenic spores, making rapid chilling and short holding times necessary to prevent growth and toxin production by non-proteolytic *C. botulinum*, which can grow at temperatures as low as 3°C *(2, 14, 17, 27)*. The survival of vegetative pathogens is also a concern with sous vide cooking, largely because of the complexities of LTLT cooking.

As with traditional cooking methods, final temperatures that are too low or cooking times that are too short can allow pathogenic bacteria such as *Salmonella* spp., *Listeria monocytogenes*, or *E. coli* O157:H7 to survive. To reduce pathogens to safe levels, all parts of the food must be held at a specific minimum temperature for a minimum length of time. With traditional (high temperature) cooking, the required holding time for pasteurization at the final cooking temperature can be nearly instantaneous, with 15 seconds or less sufficient to achieve pasteurization *(10, 11)*. These temperatures are typically promoted and regulated as "safe" cooking temperatures, and in Ontario range from 63°C to 82°C, depending on the type of food being cooked *(10, 25)*. For this type of cooking, pasteurization can be confirmed by simply measuring the final internal temperature of the food. With sous vide and LTLT cooking, this is not the case; verifying the final internal temperature does not confirm pasteurization. Instead, operators must first verify the Come-Up Time (CUT) for the food, or how long it takes for all parts of the food to reach the temperature of the water bath. Timing for pasteurization begins only after the CUT is reached. The size and shape of the food, number of food portions in the water bath, temperature of the food before being placed in the water bath, and properties of the food such as fat content can all influence the CUT and total cooking time of the product *(1, 2)*. More complex sous vide recipes can even involve multiple temperature endpoints and holding times to achieve pasteurization. The potential for error with LTLT cooking was highlighted in a 2014 report by the Advisory Committee on the Microbiological Safety of Food (ACMSF) which noted that some operators may misunderstand the difference between total cooking time, CUT, and pasteurization time *(1)*. The greater potential for undercooking of LTLT and sous vide is highlighted in two field reports published by the British Columbia Centre for Disease Control (BCCDC; *8, 9*). In one report, inadequate pasteurization of eggs cooked sous vide was linked to cases of salmonellosis; in the other, the substitution of duck for venison in a previously validated sous vide recipe resulted in undercooked duck and a link to a confirmed *Salmonella* case *(8, 9)*. In both reports, the restaurant operators did not fully understand CUT, underestimated pasteurization times, and failed to monitor or document temperatures. The BCCDC reports demonstrate that some restaurant operators are using the sous vide process without a full understanding of the risks or food safety requirements. There is considerable variability in operator knowledge and compliance in restaurants, and as sous vide cooking becomes more popular in this sector, the risk of foodborne illness will likely increase.

Increasing popularity in North American restaurants

Although sous vide was developed over 40 years ago, the technique has become more common in the past ten years, with Baldwin *(2)* and Hoeche *(16)* both describing a rise in popularity of sous vide cooking in restaurants and homes beginning in the late 2000s. Reports in the media within this time confirmed the trend. In 2006 in New York City, the sudden popularity of sous vide cooking in restaurants resulted in a temporary ban of the technique by the health department until appropriate amendments could be made to the health code. The *New York Times* reported that restaurants were ordered to stop cooking and storing sous vide foods as the health department struggled with an unanticipated need to train inspectors, develop guidelines, and incorporate sous vide training into its food handling license curriculum *(5, 6)*. More recently, after seeing a significant growth in sous vide use, food safety inspectors in Portland, Maine impounded hundreds of pounds of sous vide cooked meats until restaurant operators could prove the recipes were safe *(4)*. In both of these jurisdictions, restaurant inspectors seemed unprepared for the surge in popularity of sous vide cooking and appeared to lack appropriate training and resources prior to taking enforcement actions.

The new popularity of sous vide cooking was noted in Canadian restaurants, too. A 2008 article in the Ottawa Citizen *(26)* reported that the sous vide process was used by a few celebrated chefs in Ottawa and, unlike in New York City, there were no specific public health requirements for sous vide cooking in Canada. A later Toronto Star article *(19)* also noted the growing popularity of sous vide and observed that an Ontario sous vide food safety manual had "yet to be written."

With the expanding use of this technique in restaurants, some health authorities have responded by updating food codes or releasing guidance documents to provide standards for sous vide cooking *(1, 7, 12, 13, 22, 23, 30, 31)*. The province of Ontario has not produced any sous vide resources or legislative updates to date. This may, in part, be because the prevalence of sous vide use in Ontario restaurants is not known. There are also no published studies that detail the food safety issues related to sous vide use and experimentation in restaurants, or the experiences and needs of the Public Health Inspectors (PHIs) who inspect these restaurants.

With the growing popularity of sous vide cooking, it is likely that the technique is no longer limited to a small number of "cutting edge" restaurants in Ontario's largest cities. While some chefs have a good knowledge of food safety and the potential hazards of sous vide cooking, others may experiment with the technique without a full understanding of the food safety risks. This creates difficulties for PHIs, who may have little knowledge of sous vide and LTLT pasteurization. Lacking regulatory support, they are faced with the challenges of educating both themselves and restaurant operators on the risks of sous vide cooking, as well as proposing, evaluating, and enforcing food safety plans.

A better understanding of PHI experiences with sous vide cooking in the Ontario restaurant sector is needed, and the PHIs who have already faced the challenges of inspecting restaurants that use sous vide processes are the best source of this information.

Purpose of study

The purpose of this study is to evaluate the knowledge, experiences, and practices of PHIs with respect to the safety of sous vide cooking in Ontario restaurants, and help determine the resources needed by PHIs to better assess and enforce requirements for safe sous vide cooking. Through focus groups and interviews with PHIs who have encountered sous vide use in the field, the researchers hope to gain a better understanding of the prevalence of sous vide in Ontario restaurants and collect qualitative data that will help direct training needs, develop resources, and standardize operator requirements for safe sous vide cooking in Ontario.

MATERIALS AND METHODS

A qualitative study design was chosen, given the lack of information on both the prevalence of sous vide use in Ontario restaurants and the observations and insights of PHIs in the field. Focus group and individual interviews were used to explore PHI knowledge, experiences, and practices with regard to the use of sous vide cooking in food premises. The Research Ethics Board at the University of Guelph approved the study, and participants in both the focus group and in-depth interviews provided written informed consent. Using both a focus group and interviews allowed for group interactions where possible and still allowed for individual discussions where scheduling and minimum group numbers would otherwise exclude participants.

The province of Ontario is divided into 36 health units, which deliver public health programs to the municipalities within their geographical boundaries. Each health unit operates as a separate government agency, although all report to and receive directions from the province. Only PHIs who were currently working at an Ontario health unit and who said they had inspected at least one food premise that used sous vide cooking were asked to participate in the study. The exact number of PHIs within Ontario health units who met the inclusion criteria is difficult to estimate, but is likely to be very small relative to the estimated 900 PHIs working at health units across Ontario *(29)*.

Participants were recruited by an email request sent through the ASPHIO listserv, which includes all directors and managers of inspection programs at Ontario health units. In total, 151 ASPHIO members were sent the request for study participants. In addition, three PHI contacts within Ontario health units who had previously been identified as having restaurants using sous vide were sent an email requesting participant(s) for the study. Snowball sampling, in which some study participants referred the researcher to other PHIs or health units that might be interested in taking part in the study, was also used.

Lastly, to get a better estimate of the distribution of restaurants using sous vide cooking in Ontario, PHIs at seven Greater Toronto Area (GTA) and southern Ontario health units were contacted and asked if any food premises had been found to use the technique in their region. These seven health units were chosen because they included larger urban areas or regions known for fine dining and a diversity of restaurants and therefore were most likely to have encountered sous vide cooking.

The focus group was conducted by teleconference following a format and introductory script proposed by Krueger and Casey *(18)*, who suggested that telephone focus groups were an effective method for engaging busy professionals. The focus group discussion was semi-structured, and the researcher/moderator used predetermined, mostly open-ended questions to stimulate discussion. The questions were developed by the researcher, a PHI with some experience inspecting sous vide cooking in restaurants, and pretested by a colleague, also a PHI. The questions are included in Appendix A. Participants were provided with the list of questions in advance of the teleconference, but were informed that the list would not be limited to these questions during the discussion. The length of the discussion was limited to one hour, and ten PHIs from eight different health units participated in the focus group. Because of scheduling difficulties and a desire to include all interested PHIs, only one relatively large focus group was held, in May 2016.

Two semi-structured, in-depth, one-on-one interviews were conducted to validate the data from the focus group and allow for a greater depth of understanding of the PHI experiences. Interviews also allowed the participants to express their views without competing with other participants to be heard. One interview was done by telephone and one in-person between May and June 2016. The same questions were used in the interviews as in the focus group, with the addition of two questions about enforcement, an issue raised in the earlier focus group discussion. The interviews lasted approximately 30 minutes.

The researcher audio recorded the focus group sessions and the interviews and used the audio recordings to check the accuracy of, and to supplement, the notes made during the sessions. Some verbatim quotes were transcribed from the recordings as well. All notes were entered into Microsoft Word and then uploaded into NVivo 11 qualitative data analysis software for Mac (*QSR International Pty Ltd V.11, 2016)*, for coding and analysis. Participants and health units were coded, and their identities were removed from all notes and transcripts.

The study methodology was developed in consultation with researchers familiar with both qualitative analysis and food safety. The researcher who led the focus group and interviews is an experienced PHI working in Ontario, with a good understanding of the experiences and views described by the participants. During both the focus group and the interviews, the researcher summarized the main points of the discussion with the participants to confirm that the interpretation of their views and experiences was correct. The results of the focus group and individual interviews were compared to provide triangulation and increase the validity of the study. Further, PHI participants represented nine different health units from across southern Ontario, thus increasing the reliability of the data.

RESULTS

A total of 12 PHIs from nine different health units participated in either the focus group or the one-on-one interviews. The response to the email request sent through the ASPHIO listserv was low, with only six responses in total: five PHIs (each from a different health unit) volunteered to participate in the study, and one health unit manager responded that there were no restaurants using sous vide in the region. In addition, seven PHIs from four other health units volunteered to participate in the study after being contacted directly by the researcher or after being referred by a colleague. An additional seven PHIs representing an additional seven health units in the Greater Toronto Area (GTA) and southern Ontario were contacted to confirm whether they had identified restaurants using sous vide cooking in their jurisdictions. Three responded that they were aware of it being used but did not feel they had enough experience to participate in the study; two responded that they were not aware of sous vide being used in any restaurants in their area, although one PHI speculated that it was "only a matter of time" before it would be encountered; one indicated that the health unit was in the process of developing policies and procedures for sous vide, and one health unit had developed a position paper for use by PHIs. *Table 1* summarizes the health units in Ontario that reported having restaurants using sous vide cooking.

The focus group and interview participants had from two years' to more than 22 years' experience working as a PHIs and represented health units from across southern Ontario. No PHIs from northern Ontario health units responded to the ASPHIO request or volunteered to participate in the study. Study participants were asked about their experiences and practices related to sous vide within their health unit. Concerns about food safety, identification, and enforcement emerged as common themes across the focus group and interviews.

Experiences

The participants reported restaurants cooking a wide variety of foods using the sous vide method. The process was frequently observed to be used for cooking beef, including steak, prime rib, and hamburgers. With beef, a finishing step was always used to sear the product before serving. Chicken, duck, eggs, lamb, bacon, fish, and seafood were also found to be cooked using sous vide, as were a variety of vegetables and desserts such as crème brûlée.

PHIs found sous vide cooking being used mostly in "higher-end" restaurants, including those operated by large hotel chains, which employed the technique for banquets and weddings. Sous vide use was also reported in a casino and in a number of culinary schools. Interestingly, a high level of sous vide cooking was reported in ramen restaurants, where chicken and eggs were commonly cooked using sous vide.

The study participants all reported that the immersion circulator was the type of equipment most commonly observed in the restaurants that use sous vide cooking. An immersion circulator is a portable device that can be attached to the side of any container that holds water. It is set to bring the water to a specific temperature for a specific time and continuously circulates the water to ensure that a uniform temperature is maintained throughout the container. It takes up very little space in the kitchen and can be stored out of the way when not in use.

Although sous vide cooking was a selling point for some of the fine dining restaurants, notably for seafood, many more restaurants did not actively promote sous vide on their menus. In some, serving staff would be responsible for describing the cooking process to diners when asked about applicable menu items.

PHIs relayed a number of advantages of sous vide that were explained to them by chefs during inspections. With seafood such as octopus, it improves the texture and flavor of the finished product by preventing overcooking. It allows eggs to be cooked and still retain a desirable runny consistency for ramen dishes and steak tartar. In the case of beef, it breaks down muscle and makes meat very tender while still allowing it to retain a "pink" color. Operators also praised the convenience of sous vide cooking, as the process facilitates mass production at banquets and produces highly consistent food. Smaller operators also touted the benefits of the sous vide process in time management.

While the PHIs themselves reported using the BCCDC Guidelines for restaurant sous vide cooking *(7)* as their

TABLE 1. Health units confirmed to have encountered sous vide

Health Unit	Sous Vide Encountered?	Study Participants
CZB	Yes	1
CJZ	Yes	2
BNK	Yes	1
B5C	Yes	3
C74	Yes	1
DG4	Yes	1
DY4	Yes	1
D7H	Yes	1
DL4	No	1*
F89	Yes	0
FDK	Yes	0
FS2	Yes	0
FYD	No	0
GFT	Yes	0
GNB	No	0
GQL	No	0
HQ9	Yes	0

*PHI who participated had previous experience with sous vide from working in a different health unit.

primary resource for sous vide food safety information, restaurant operators did not. Some chefs, typically those on the forefront of sous vide cooking, had trained with experts in sous vide and had a wealth of experience and knowledge about the technique. Some had books on sous vide written by well-known chefs. Internet searches and smart phone apps were also reported as popular sources of sous vide information for operators.

Food safety

Although most of the participants had generally positive experiences with operators using sous vide cooking, they expressed concern that the growing popularity and accessibility of the technique would inevitably lead to its adaptation by less qualified or reputable operators. As one participant (PHI 464) stated, "I don't think we have to be concerned about our big chefs. It's when it expands into those outer areas."

Experimentation by operators who do not fully understand the food safety risks of sous vide cooking was a notable concern. Problems with documentation, a failure to confirm cooking temperatures, and attempting to cook whole carcasses too large to be pasteurized effectively had already been observed by some PHIs in the course of their inspections. Although many PHIs reported some issues with documentation by operators, only one PHI had encountered an operator who had a poor understanding of the risks of the sous vide process and prepared a hazardous food item that was likely not pasteurized and would be unsafe for consumption without further cooking. This case involved an operator cooking chicken breasts sous vide to a temperature of 74°C, at which pasteurization occurs in less than 10 seconds *(10)*. The operator added the chilled chicken to the hot water bath (set to 74°C) and set the timer for one hour, never checking either the temperature of the water bath or the finished internal temperature of the chicken breasts. On checking the temperature of the water bath with a calibrated probe thermometer, the PHI found it was 5°C lower than the reading. The bath was also being overfilled with product, which prevented efficient circulation of water around each chicken breast.

Not surprisingly, the participants had a good understanding of the food safety risks of sous vide cooking. Although some reported little or no knowledge of sous vide when they first encountered it, all had researched the method after-

wards. The biggest food safety concern for most was the low temperatures used in sous vide and the possibility of pathogen survival. Concern over the botulism risk with freshwater fish was also mentioned. A number of PHIs reported taking samples of sous vide cooked foods for analysis; none tested outside of acceptable parameters. In Ontario, food samples are generally tested for aerobic plate count, total coliforms, *E. coli*, and total gram negative bacteria, as well as for foodborne pathogens such as *Salmonella* species, *Campylobacter* species, *Staphylococcus aureus*, and *Clostridium perfringens*. Limits for each, depending on the type of food, are outlined by Public Health Ontario *(24)*.

Practices

A few PHIs stated that their health units had asked for assistance related to sous vide cooking from the Ontario Ministry of Health and Long-Term Care (MOHLTC) and Public Health Ontario (PHO), the first request being made about eight years ago. With the apparent rarity of sous vide cooking at that time, health units were directed to follow the U.S. requirements *(30, 31)* and the development of specific directions or guidelines was not deemed necessary.

A few PHIs who worked in areas where sous vide was more prevalent indicated that their health units had set up sous vide working groups and were in the process of developing policies and procedures for PHIs. These health units hoped to standardize requirements for sous vide cooking and improve consistency among PHIs in their inspections. One of these health units had also arranged for a university student to complete a study on the sous vide cooking process *(15)*, and in early 2016 produced a fact sheet on sous vide cooking. Training of PHIs was also planned. Another health unit that was contacted by the researcher but did not participate in the study stated it had produced a document outlining the requirements for operators using sous vide cooking; operators were required to demonstrate a safe process by providing a detailed HACCP plan and to take a food sample of the final product for microbiological analysis by a private laboratory.

All study participants stated that they assess restaurants on a case-by-case basis, with no official guidelines being followed, although the BCCDC Guidelines for restaurant sous vide cooking *(7)* was the current reference of choice for most. The need for consistency in approach across Ontario was recognized, despite each health unit developing its own procedures independently.

Identification

Regardless of whether they participated in a focus group or an interview, all PHIs in this study expressed concern there were likely far more restaurants using the sous vide process in Ontario than they were aware of. Many reported that once they discovered an operator was using sous vide cooking and learned more about it, they began finding it in the other restaurants they inspected. One PHI described regularly observing vacuum packaged meat portions at one restaurant but never making the connection with sous vide until discovering a water bath on the counter and asking what it was used for. Compounding the difficulties in identifying sous vide use was the acknowledgement that operators rarely bring it up without provocation.

As one participant (PHI 464) stated, "You have no idea that they might even be doing sous vide and don't know to ask." This sentiment was echoed in both the focus group and interviews. Even conscientious operators with good knowledge of food safety did not volunteer information that they were using sous vide.

One PHI (597) summed up the feeling of all participants with the statement, "People don't tell us things."

Enforcement

The enforcement of safety requirements for sous vide cooking was a concern in both the focus group and interviews. It was noted that Section 33 *(13)* of the Ontario Food Premises Regulation *(11)* permits an exemption from prescribed cooking temperatures and times if the Medical Officer of Health (MOH) is satisfied that a different time and temperature combination is safe. Whether this Section could be used to enforce the rapid cooling, cold holding and limited holding times required for safe cook-chill sous vide processes was, however, questioned. Rather than require the operators to submit a food safety plan, one PHI stated that his/her health unit was requiring restaurant operators to provide their sous vide recipes for approval by the PHI. Recipes would have to be species or portion size dependent and could not be changed without approval. If an operator was found using a sous vide recipe that had not been approved by Public Health, he/she could be charged with failing to cook food to the temperatures prescribed in O. Reg. 562/90 *(12)*. There was general consensus among the participants that this was a good approach to enforcement, and when PHIs found sous vide equipment during an inspection, they would require the operator to submit recipes for approval.

DISCUSSION

The PHIs who participated in the focus group and in-depth interviews provided valuable information about their experiences, practices, and views regarding sous vide cooking in restaurants. Their input revealed sous vide use in Ontario restaurants is likely underreported because of difficulties faced by PHIs in identifying when it is being used. If the use of sous vide processes is not identified, the effective promotion and enforcement of safe sous vide cooking cannot begin. All participants expressed concern that, inevitably, some operators will adopt sous vide cooking processes without the knowledge or skills to do it safely. To educate these operators and enforce requirements for safe sous vide cooking consistently, many PHIs identified

the need to have standardized requirements for sous vide cooking. Some reported that their health units were working to develop resources to this end, whereas others did not. The development of training resources for PHIs in Ontario would enable them to identify when sous vide processes are being used in a restaurant and would ensure that operators understand and mitigate the food safety hazards associated with the cooking technique.

Perhaps the most telling information gained from the study is that the use of sous vide in Ontario restaurants, though by no means ubiquitous, is likely more widespread than initially thought. The problem lies in its identification. The study participants in both the focus group and interviews remarked that they found more operators using sous vide once they knew what to look for and what to ask. In other words, if you're not looking for it, you're not as likely to find it. That sous vide cooking is often limited to only a few menu items, can be used for almost any food, and is frequently not promoted, further complicates its identification. So, too, does the fact that study participants identified immersion circulators as the equipment most commonly seen in their inspections.

With an immersion circulator, the various containers that can be used for the water bath can have multiple uses and are not identifiable as sous vide equipment unless observed when set up for use. Further, immersion circulators are relatively compact and can be stored out of sight when not in operation. The presence of vacuum packaged foods, although in itself not indicative of sous vide use, was also noted as a sign of sous vide cooking by one of the study participants. Knowing that these items can be used for sous vide is important, because seeing them will prompt questions from PHIs. Training PHIs to recognize possible sous vide equipment and to know the requirements for safe sous vide cooking before they encounter it would enable them to identify its use and ensure the safety of the process sooner. This is particularly important when dealing with restaurant operators who are not using the process safely or who lack a good understanding of the foodborne illness risks. To be most effective, training needs to be made available to all PHIs working in the food safety program. The keys to identifying sous vide cooking in a food premise are knowing what to look for and what to ask the operator.

While the study participants reported largely positive experiences with operators using sous vide cooking, all PHIs expressed concern that its growing popularity and accessibility would inevitably lead to the use of sous vide cooking by operators who were ignorant of the food safety risks or simply non-compliant. The Advisory Committee on the Microbiological Safety of Food (ACMSF) noted that there seemed to be confusion among some operators in understanding the difference between the time a food product is in the water bath and the pasteurization time for the product *(1)*. The total time a food product must be "cooked" in a water bath is a combination of the CUT and pasteurization time, and operators failing to account for both will fail to pasteurize the product. The unique food safety risks and complexities of LTLT pasteurization make temperature abuse a significant concern with foods cooked sous vide.

The expansion of sous vide into a growing number of restaurants is likely, in part because of the increased accessibility of sous vide equipment. Now, with increased marketing of sous vide cooking to the home chef, equipment prices have fallen considerably *(16)*. For example, Sansaire, Nomiku, and Anova all produce immersion circulators for the home market ranging in price from $199 to $299 U.S. *(20)*. The reliability and accuracy of lower priced equipment is unknown, but smaller restaurant operators who wish to experiment with the technique are more likely to purchase less expensive home models to minimize expenses. Complementing the increased availability of affordable equipment is the wealth of sous vide cooking information available online, as well as a number of sous vide smart phone applications. For example, Polyscience, Anova, Nomiku and Sammic all have apps for sous vide cooking, and the Joule immersion circulator by ChefSteps relies completely on a smartphone application for its operation *(3)*. Whether the times and temperatures prescribed in the various smart phone apps were developed to achieve adequate log reductions in pathogens is not known. Moreover, the widespread availability of quick, unvalidated time and temperature references online and in smartphone applications distances the cook from any underlying food safety principles used in their development.

As an example, *Table 2* summarizes five recipes for sous vide cooked chicken salad found online. All five do no more than advise the users to cook the chicken breasts at a specific water bath temperature for a specified length of time. No mention is made of the CUT, pasteurization time, or the effect of size or thickness on cooking time (although some recipes provide a time range for cooking). Nor are any recommendations made to confirm the temperature of the water bath or the internal temperature of the chicken breasts. At the water bath temperatures prescribed in the recipes, pasteurization times would range from about two minutes to as long as 35 minutes *(10)*. In short, food safety is not addressed in any of these recipes. While this does not mean that foods cooked by following the recipes are necessarily unsafe, it does mean that there is greater room for errors that could lead to foodborne illness.

The author of an unpublished study of sous vide processes in Toronto restaurants *(15)* compared the time and temperature combinations recommended by sous vide equipment manufacturers. All were slightly different, as was the indicated thickness of the food. The overabundance of information on sous vide can be confusing, and the standards used by these companies in creating their recipes is unknown. For Canadian food processers, the Canadian Food Inspection

TABLE 2. Summary of five online sous vide recipes for chicken salad

Internet Recipe*	Temperature/Time
https://recipes.anovaculinary.com/recipe/sous-vide-chicken-salad	Cook boneless, skinless chicken breasts at 145°F (62°C) for 1 hour.
https://www.seriouseats.com/recipes/2015/06/the-best-classic-chicken-salad-recipe.html	Cook bone-in, skin-on split chicken breast halves at 150°F (66°C) for 1 to 4 hours.
https://www.tastingtable.com/cook/recipes/chicken-salad-sous-vide-recipe	Cook chicken breast at 150°F (66°C) for 2 hours.
https://recipes.anovaculinary.com/recipe/waldorf-chicken-salad	Cook boneless, skinless chicken breasts at 140°F (60°C) for 2 hours.
https://pudgefactor.com/sous-vide-chicken-salad-veronique/	Cook bone-in, skin-on chicken breasts at 150°F (66°C) for 2 to 4 hours.

*All recipes accessed 6 June 2018

Agency (CFIA) requires a 6.5 log reduction in *Salmonella* for meats and a 7 log reduction in *Salmonella* for poultry *(10)*. This level of reduction in *Salmonella* is considered protective of more vulnerable groups in the population, such as children and the elderly. Sous vide recipes do not necessarily correspond to this level of pasteurization and may have been developed as safe for the average healthy, adult consumer. For example, Baldwin *(2)* suggests that a 3 log reduction in *Salmonella* is sufficient for immune-competent consumers. To reduce confusion, increase standardization of inspections, and facilitate enforcement, a sous vide food safety reference that is approved and endorsed by the MOHLTC is needed.

While safe sous vide guidelines in Ontario are needed to standardize and assist enforcement in restaurants, there are still other issues with enforcement that are less easily resolved. Both focus group and interview participants expressed concern regarding the logistics of enforcing safe sous vide cooking in restaurants. One health unit's planned approach of approving each sous vide recipe individually received support during the focus group discussion. The thought was that recipe approval was a simpler and less daunting process for the restaurant operator than submission of a detailed HACCP plan. A simpler process for the operator likely means better disclosure and compliance. Moreover, a number of PHIs indicated that requirements for sous vide cooking should not be unnecessarily prohibitive. Regardless of whether an operator is required to provide detailed HACCP plans for his/her sous vide processes or to submit individual sous vide recipes, the approval process for PHIs will likely be time consuming.

Health units in Ontario are often compelled to develop their own resources independently, rather than making requests for assistance from PHO or the MOHLTC. Different health units have different capacities and needs for resource development. In the case of sous vide, only those health units that have higher numbers of restaurants using the process are likely to devote time and expense to resource development. Similarly, those health units with the most sous vide experience are more likely to recognize the importance of PHI training prior to implementing health unit wide sous vide restrictions. Study participants noted that PHIs need to be able to identify equipment, know what questions to ask of operators, and respond in a professional manner when confronted by the "new" cooking technique. This need extends to all PHIs in Ontario. Thus, training resources and guidelines for sous vide cooking must be developed and distributed across the province to ensure access for all health units. Whether used for a few special menu items at a high-end bistro or for the mass production of meals at a wedding banquet, sous vide must be done safely, and the same standards must be applied across the province.

The same can be said outside of Ontario as well. Sous vide cooking in other jurisdictions is likely underestimated and under-enforced for the same reasons found in Ontario. If health inspectors are properly trained before they encounter sous vide, they will be better able to assess risk and take consistent education and enforcement actions when they do find it.

Limitations

McCracken *(21)* suggests that for many qualitative research projects, eight respondents are often sufficient because each respondent provides a greater depth of information than in quantitative studies. In this respect, 12 participants can be considered an adequate sample size for the study. However, the data gathered from the participants cannot alone be considered representative of all Ontario PHIs with sous vide experience.

A limitation of the study is the lack of participants from those health units that had identified sous vide use in their jurisdictions. Three PHIs confirmed there were restaurants identified using sous vide in their area, but they felt they did not have enough experience with sous vide cooking to participate in a focus group or interview. Some selection bias may be expected in that perhaps only those PHIs who had more experience with sous vide volunteered for the study. Additional or different concerns might have been raised by these PHIs who were less confident in their experience with sous vide cooking, particularly with regard to the practices of the health unit at which they were employed. It is also impossible to discern whether a non-response to the study request was because PHIs had not encountered sous vide in a particular health unit jurisdiction or because they were not interested in participating.

RECOMMENDATIONS

The study allowed for the investigation of PHI experiences, practices, and challenges with regard to the inspection of Ontario restaurants using sous vide cooking. A fundamental theme arising from the focus group and in-depth interviews was the challenge of identifying restaurants that use the sous vide process, particularly for those PHIs who have never before observed sous vide cooking. It is apparent that sous vide use in Ontario restaurants is a trend that is not unique to a single health unit and that the practice has gone largely unnoticed and unregulated in many restaurants. Its popularity and use is likely underestimated.

Before improvements can be made in the identification of restaurants using sous vide, the endorsement of standard sous vide guidelines at the provincial level is needed. Without a benchmark reference for safe sous vide cooking in Ontario, there will be inconsistencies both within and across health units in the province. Standard guidelines for Ontario would allow for a more consistent approach to promotion and enforcement, and help both PHIs and restaurant operators navigate the numerous sous vide cooking references that exist, particularly online.

Once standard guidelines for safe sous vide cooking are established in Ontario, training resources for both PHIs and restaurant operators need to be developed. Safe sous vide training should then be promoted to all PHIs working in the food safety program, not just those working in areas known to have restaurants using the sous vide process. Training would enable all PHIs to better recognize those restaurants using sous vide cooking and ensure that proper control measures are implemented to prevent foodborne illness.

Regardless of whether an operator is required to provide detailed HACCP plans for his/her sous vide processes or to submit individual sous vide recipes, the approval process for PHIs will likely be time consuming. The establishment of provincial guidelines and training resources for safe sous vide cooking would help ensure that the approval of sous vide recipes and/or food safety plans is done correctly the first time and to standards that are consistent across the province and, ideally, internationally.

Although this study focused on the experience and needs of PHIs in the province of Ontario, the findings can provide useful information to any jurisdiction where the prevalence of sous vide use in restaurants is unknown and region-specific resources are not available. Proactively providing both inspectors and restaurant operators with education and training that is consistent with what is used internationally is strongly recommended.

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*Guidelines were originally released in 2014 and then updated in 2016.

APPENDIX A: FOCUS GROUP AND INTERVIEW QUESTIONS

1. How long have you been working as a public health inspector?
2. What do you know about sous vide and how did you learn about it?
3. How are you finding out that restaurant operator(s) are using sous vide?
4. What kind of foods do your restaurants cook using the sous vide method?
5. Do you have any food safety concerns with restaurants using the sous vide method?
6. Have you had any problems with restaurants using sous vide?
7. What requirements do you have for operators using sous vide?
8. Are there any resources you would like to have developed for sous vide safety?
   Who do you think is the best organization to develop these resources?

Additional Questions Used Only in Interviews:

9. The question of enforcement has come up in my discussions with other PHIs.
   Do you have any concerns regarding the enforcement of safe sous vide cooking in food premises?
10. How do you think sous vide cooking is best enforced?