BC Centre for Disease Control
An agency of the Provincial Health Services Authority

Environmental Health Services

Food Issue

Notes from the Field

Sous vide of shell eggs

Request received from:	Regional Health Authority
Date of request:	January 9, 2015
Issue (brief description):	A premise with 2 confirmed *Salmonella enterica* var. Enteritidis (SE) was using the sous vide technique on shell eggs. Evaluate the process of shell egg sous vide for risk in transmission of SE.

Summary of search information

1. Internet sources: Google scholar search of key references (Doyle/Schuman)
2. Other: contacted Chef for best practices

Background information

Shell eggs most often become contaminated through vertical transmission from an infected layer hen (81%), and can also become contaminated from environmental sources (19%), known as horizontal transmission.[1] The composition of a shell egg is shown below. Studies demonstrate contamination can be found within the egg yolk interior, as well as albumen and vitelline membrane layers.[1,2] Cracks and pores in the egg shell, as well as temperature, condensation and other factors allow penetration of pathogens into the egg shell.[3]

What are the risks associated with Salmonella Enteritidis and shell eggs?

In Canada, approximately 6.3 billion eggs were produced in 2005 (likely closer to 7 billion in 2014), and 75% of them were sold as table eggs[5]. The most recent risk assessment in Canada in 2011 by DeWinter *et al* estimated 1.7 million SE contaminated grade A table eggs will be produced annually in this country.[6] An outbreak in a US restaurant that received eggs from a heavily contaminated area (from SE-positive farms) found contamination rates as high as 1 in 12 SE contaminated eggs were served to customers.[7] Canadians from all segments of the population consume eggs up to 3X per week. SE infections can range from mild to serious, requiring hospitalization when septicaemia and infections occur, although deaths are rare.[8] Assessment of outbreak data finds that most illnesses are attributed to poor handling

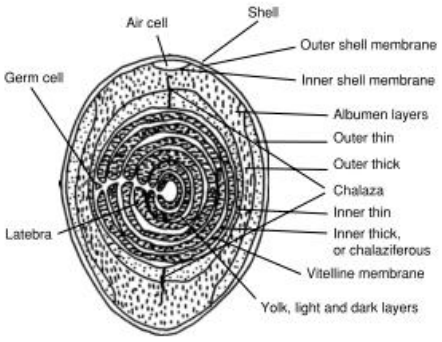

Figure 1
Structure of shell egg [4]

and temperature control of table eggs. DeWinter reports that *"poor storage and handling conditions representing 0.6% of exposures result in 46% of illnesses; eggs handled under ideal storage and handling conditions account for 96% of exposures and represent 49% of illnesses."* [6] A risk assessment conducted in the US compared how the annual number of SE illnesses could be reduced in the population if eggs received a pasteurization treatment[9]:

None	3 log	5 log
130,000	41,000	19,000

Shell eggs causing SE illnesses have been attributed to a variety of uses, as shown in Figure 2.[1] In BC, a large outbreak of SE involving eggs at a bakery caused over 35 illnesses.[10] Periodic outbreaks involving clusters of illness in BC food premises have also been reported, and linked to raw table eggs used in desserts such as tiramisu, and dressings such as Caesar or hollandaise (personal communication).

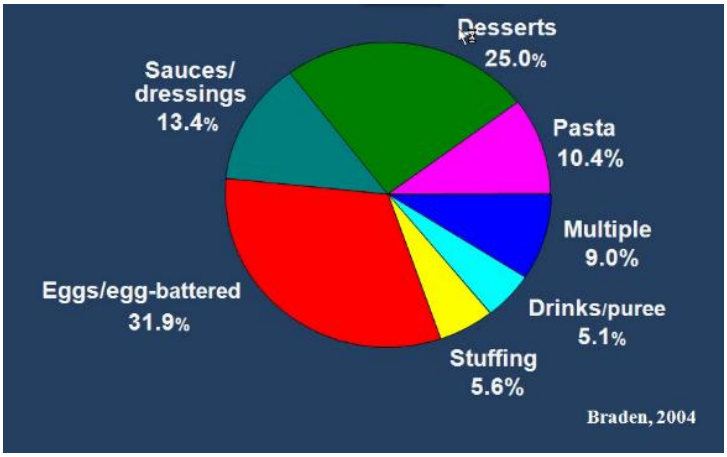

Figure 2
Confirmed vehicles that are egg-associated (*note: not able to locate original reference cited on slide from this presentation*)

Therefore, to control the risk of SE growing in eggs, proper temperature control in a food premise is required. Temperature controls in the premise would include proper refrigerated storage of raw shell eggs upon receipt, adequate cooking or pasteurization of eggs prior to service, and proper cooling of pasteurized eggs.

Previous guidance on sous vide style cooking and pasteurization of shell eggs from British Columbia

The *Guidelines for restaurant sous vide cooking safety in BC* were released in September 2014.[11] However, these guidelines do not specifically address shell eggs and sous vide style cooking. As these guidelines were released less than six months ago, it is unknown how individual premises are putting these guidelines into practice. Table 3 in the guidelines specifies how to achieve a 7 log reduction for *Salmonella* in poultry, and 6.5 log reduction for *Salmonella* in other meats.

We believe that the information contained in the guidelines is accurate – as long as the time and temperature guidance is applied to the yolk interior.

The BC Chefs Association reports the normal temperatures used for sous vide style egg cookery is between 62°C (144°F) and 70°C (158°F), usually between 62 – 65 °C is used (pers. comm.).[12] The length of time for sous vide egg cookery should be approximately 45 minutes. Eggs are normally cooled in a 50:50 ice water bath to rapidly cool down the temperature and to assist with peeling of the egg.

Note: the cooking time = CUT + Pathogen Reduction time, Table 3. I.e. 30 min CUT + 15 PR time. If so, the hold at 62°C for 15 min > 12.4 min (62.2°) listed in the SV Guidelines. This guidance is good and is consistent with our current guidelines.

Guidance on pasteurization of shell eggs (elsewhere in the world)

Penetration of heat into an intact shell egg is slow, likely as eggs by design are not efficient conductors of heat.[13] Previous studies demonstrating full 7 log reduction of *Salmonella* in eggs have shown that immersion of shell eggs in water heated to 58°C required between 50 to 57.5 minutes, and at 57°C required slightly longer, between 65 to 75 minutes.[14] The come-up-time to reach these internal water bath temperatures varied between 24 and 35 minutes.[14]

These results are consistent with more recent experiments conducted in 2011 to validate industrial scale egg pasteurization temperatures.[1] In Figure 3, below, an experiment was conducted by Dr. Geveke (an engineer) with 48 shell eggs, held in a large lobster pot, with the eggs stacked in perforated trays. The water was circulating and heated in the lobster pot. In this experiment, he tested triplicate batches of eggs at three temperature ranges that spanned the range of pasteurization of eggs before coagulation of the egg whites could occur: at 54.4°C (low temp), 55.6°C (moderate temp) and 56.7°C (high temperature).

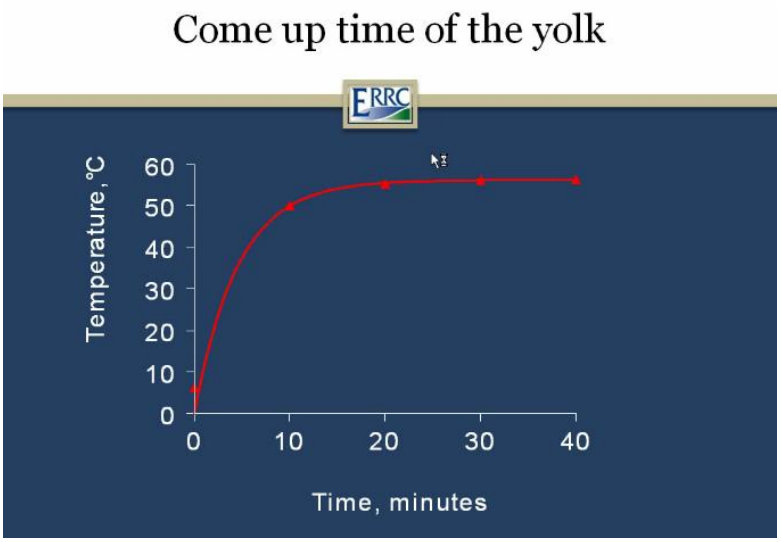

Figure 3
Come up time of the yolk for shell eggs in water immersion conditions

His experiment revealed the come-up time for the egg yolk interior and found that it take 30 minutes for the yolk to reach the actual temperature of the water bath. It took a further 30 minutes to get a 4.5 log reduction in heat resistant strains of *Salmonella* (for a total time of 60 minutes) at 56.7°C and 100 min total for a 4.5 log reduction of *Salmonella* at 55.6°C. After 120 minutes at 54.4°C only a 2.5 log reduction of *Salmonella* could be achieved, and this temperature was deemed unsuitable for large commercial pasteurization of eggs.

D-values at these temperatures were reported as 9.33 min at 56.7°C, 14.6 min at 55.6°C and 51.8 min at 54.4°C (Z value of 3.07).

Issues associated with the sous vide egg style cooking reported in the premise

The actual method reported for sous vide egg style cooking is outlined in Appendix 1. Issues noted in the process include:

1. The bowl used to hold the eggs did not allow for water circulation within the bowl. We feel it extremely unlikely that the immersion circulator water temperature would heat up the eggs, especially those in the middle of the bowl, to the target temperature.
2. The operator did not specify in the original recipe how long it took for the eggs to equilibrate (achieve equilibrium cooking or come-up-time) with the temperature setting of the immersion circulator, nor did they specify the holding period required for pasteurization (outlined in table 3). This should be clearly stated in each sous vide recipe and food safety plan.
3. The period of time for cooling on the cookie sheet was not clarified. Cooling is a CCP, however, if the shell eggs were not been properly pasteurized, then the cooling step will further amplify any *Salmonella* present in the egg.

We believe it is more likely that eggs in the middle of the bowl remained in the danger zone for the full 2 hours, followed by further holding within the danger zone when “cooling” on the cookie sheet. Further reheating of the eggs before service would again allow opportunity for *Salmonella* amplification.

Recommendations from BCCDC

Based on the sous vide recipe and description from the inspector’s investigation we recommend the following to provide food safety assurance for sous vide style cooking of eggs in this premise:

1. The equipment used for sous vide style cooking must perform correctly, i.e., the immersion circulator must allow for water circulation to allow for rapid water equilibration.
2. The operator should independently verify the temperature in the immersion circulator is correct, i.e., compare to the setting or reading on the immersion circulator equipment.
3. Where a container, such as a stainless steel or plastic bowl, is used to hold the eggs in the water the container must be perforated to allow for adequate water circulation and heat exchange.

4. The quantity of eggs processed in a batch must not exceed the heating capacity of the immersion circulator. This may need to be demonstrated and documented through in house experimentation.
5. All eggs must be fully immersed into the immersion circulator, and weighted down if required.
6. The operator should revise and amend the food safety plan to incorporate the times and temperatures required for equilibrium cooking and hold-at-temperature cooking (CUT and time required for pasteurization in Table 3 for poultry).
7. The come-up-time or equilibrium cooking period for the yolk in shell eggs has been established in two separately published studies as a minimum of 30 minutes under ideal conditions. We recommend the operator use a minimum CUT of 30 minutes, unless a separate time can be established through temperature verification. In general, a total time in the immersion circulator must be at least 45 minutes at temperatures no lower than 62°C.
8. The cooling process should be defined. Cooling in a 50:50 ice water bath with potable water and ice is recommended to rapidly bring down the temperature.
9. The warming process before service, and length of time eggs are held should also be defined, and consistent with the BC sous vide cooking safety guidelines.

Further recommendations for BCCDC

- Write up a section about sous vide egg style cooking, review with Chefs and EHOs from the sous vide working group, and incorporate into the guidelines.
- Notify the public health community and Chefs of the possible link between SE and sous vide style cooking of eggs.

References

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Appendix I. Description of the sous vide style cooking process of shell eggs from the implicated premise.

- 60 eggs are taken from a 3.5°C cooler and placed into a stainless steel bowl (no holes)
- The bowl is immersed into a 17L immersion circulator set at 62.5°C
- The eggs are held at 62.5°C for 2 hours
- Eggs are cooled on a cookie sheet at room temperature
- Eggs are reheated before service

An inspector checked the temperature of one egg (after sous vide pasteurization)and the temperature measured 55°C in the egg interior. The appearance of the egg whites were part white and part translucent and the egg yolks were runny and yellow.

Following instruction from the inspector to validate the recipe for the sous vide style egg cooking process the operator reported the following results.

- 30 eggs held at 3.5°C were placed into a stainless steel bowl
- The bowl was immersed into a 17L immersion circulator set at 63°C
- The temp of the immersion circulator dropped after adding the cold eggs and recovered to 63°C in about 10 minutes
- It took a further 22.5 minutes for the eggs to come up to 63°C
- The eggs were held for a total of 45 minutes.
- The eggs were cooled in a 50:50 ice water bath