Microbiological quality of Portuguese custard tarts in Toronto—a pilot study

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Abstract: Custard poses a health risk as it can support microbial growth; however, few studies have investigated custard tarts as a potential hazard. Custard tarts were sampled from 14 Toronto bakeries for microbial quality, pH, and water activity. The custard tarts displayed the ability to support microbial growth, with a pH of between 6.3 and 6.5 and a water activity of between 0.94 and 0.96. No microbiological results exceeded the Ontario limits for post-production contamination levels of *Staphylococcus aureus*, *Escherichia coli*, and coliforms. It was concluded the heat used during the baking process likely kills any pathogens present and creates a surface too dry to support microbial growth. Therefore, custard tarts may not inherently pose the same risk as non-contained custard desserts.

Key words: Custard tarts, microbiological quality, intrinsic parameters.

Introduction

Portuguese custard tarts are a bakery product that has a sweet custard filling surrounded by a flaky crust. There are very few studies that have investigated this specific type of product, but other studies on similar custard-based baked goods have suggested custard can support microbial growth and lead to illness if contaminated (Barnes and Edwards, 1992; Evans et al., 1996). Proper temperature controls are a vital preventative measure against the growth of pathogenic organisms, and by storing food at 4°C or less most bacterial species will have limited growth (Ontario Agency for Health Protection and Promotion, 2013).

This type of product has been previously associated with foodborne illness. A community outbreak resulted from *Salmonella* Enteritidis contamination at a bakery in Cardiff, Wales, in 1992 (Evans et al., 1996). The custard slices responsible for the outbreak had been cross-contaminated during the preparation stage of the cold-custard mix, and once the custard slices had been made they were not refrigerated (Evans et al., 1996). Similarly, another bakery selling custard slices caused multiple cases of food poisoning in the United Kingdom in 1991 (Barnes and Edwards, 1992). The bakery had changed its recipe to include fresh shell eggs and was not fully cooking them before sale, resulting in the contamination of the custard slices with *Salmonella* Enteritidis (Barnes and Edwards, 1992). Prior to their sale, the custard slices had been held at ambient temperature during storage and transportation, and they were then left at 10°C for display in the shop (Barnes and Edwards, 1992). The improper cooking and the lack of temperature controls leading up to the sale left the *Salmonella* in a perfect medium for growth. These custard-related outbreaks highlight the potential for foods containing custard to be a food safety concern.

In the Little Portugal area of Toronto, there are bakeries selling 5,000 to 15,000 Portuguese custard tarts a week. Some of these bakeries display their tarts at room temperature. Bakeries often leave their foods, such as pastries, muffins, cakes, and breads, at ambient temperature despite having high internal water activities because the baking process makes them shelf stable (US Food and Drug Administration (FDA), 2014). Products that are baked or fried reach a very high temperature that will kill most vegetative pathogens, such as *Salmonella*. This process also removes most moisture from the product surface, and when it is stored at room temperature it continues to lose moisture to the atmosphere, reducing the pathogen's ability to grow on the surface (FDA, 2014). Portuguese custard tarts are baked at high temperatures that would kill vegetative bacteria, and in turn also produce a very dry outer layer, suggesting they should be safe at ambient temperature (anonymous bakers, pers. comm., February 8, 2016). However, eggs are also used in the production of the custard which introduces the risk of post-production contamination of the food with *Salmonella*.

A pilot survey of Portuguese custard tarts sampled from bakeries in Toronto was undertaken in Fall 2015 and Winter 2016. Samples were tested for pH and water activity as well as for a range of micro-organisms to assess the potential food safety risks with this type of custard product.

Methods

Sample collection

Techniques recommended in the Public Health Inspector's Guide to the Principles and Practices of Environmental Microbiology (2013) were followed to take and transport the Portuguese custard tart samples. Fourteen bakeries were visited and two tarts were collected from each bakery to be sampled.

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Tart samples from the first sampling day were brought to the University of Guelph and the Toronto Public Health Ontario laboratories for testing, whereas tart samples from the second sampling day were only given to the Public Health Ontario laboratory. All samples were taken using aseptic techniques and placed into labeled sterile plastic sample bags equipped with round wire for closure. The collected samples were stored in a large dry cooler containing three ice packs that kept the temperature at 4° C or less. The samples were either delivered on the day of sampling or held at 4° C in a refrigerator overnight before being brought in a cooler of the same temperature to the laboratory. A questionnaire was also given to the bakers at each bakery sampled. This outlined the cooking process, ingredients, storage location, and the current age of the tarts being sampled. If someone was not available to answer the questionnaire at the bakery then the owner was emailed and asked to answer the same questions.

Microbiological examination

Two methods were used to identify *Escherichia coli* and coliform bacteria. The first was the FDA/BAM method and the second involved 3M Petrifilm *E. coli* count plates. The MFHPB-21 method published by Health Canada was used to test for *Staphylococcus aureus*.

Intrinsic parameters

A Decagon AquaLab device was used to test the water activity of the Portuguese custard tarts following the MFLP-66 method. The pH was measured using the Public Health Ontario laboratory method. This involves a Hydrogen ion measurement with an ion-selective electrode as mentioned in the Public Health Inspector's Guide to the Principles and Practices of Environmental Microbiology (2013).

Results and discussion

A total of 14 bakeries were visited and 42 custard tarts were sampled. The 14 bakeries visited were selected because they were responsible for the production and distribution of Portuguese custard tarts in the greater Toronto area.

The results of the pH and water activity testing of the Portuguese custard tarts sampled are shown in Table 1. The results show a neutral pH, averaging at 6.3, and a high water activity, averaging at 0.95 (Table 1). All microbiological results gave negative results for bacteria tested (results not shown). It was concluded that whilst the pH and water activity results would potentially allow bacterial growth, no microbial indicators were present at detectable levels.

The questionnaire results are presented in Table 2. These results show that the methods of preparation and storage of custard tarts is consistent among all the sampled bakeries. However, some bakeries sold tarts that had been sitting at room temperature for more than one day (Bakery B and L, Table 2), which could be a food safety concern if post-treatment cross-contamination were to occur.

According to the US FDA (FDA, 2014), when food items are baked, they generally reach a temperature high enough to kill vegetative pathogens. The data collected from the bakers during the sample collections revealed that the tarts were baked to between

Table 1. Intrinsic parameters of Portuguese custard tarts in Toronto

Bakery	pH	Water activity
A	6.4	0.95
B	6.5	0.96
C	6.3	0.95
D	6.3	0.96
E	6.4	0.94
F	6.1	0.95
G	6.5	0.95
H	6.2	0.95
I	6.3	0.95
J	6.3	0.95
K	6.1	0.95
L	6.2	0.94
M	6.2	0.94
N	6.3	0.94
Average	6.3	0.95

265° C and 343° C. It was also stated by the FDA (FDA, 2014) that baked items left out at room temperature tend to lose moisture to the atmosphere, making the surface even dryer. However, other aspects of food safety must be considered. Portuguese custard tarts are made with eggs, a hazardous item that is at risk of contamination from *Salmonella*. This means the working environment in such bakeries will be at risk of cross-contamination from *Salmonella* and post-production contamination of the food could occur.

In Australia, custard is classified as a hazardous food, and any food item containing custard is required to be refrigerated due to previous outbreaks, primarily related to custard slices (New South Wales Food Authority, 2008). However, it is important to note that although custard slices and custard tarts both contain custard they are very different food items; custard slices have no crust to protect the interior, unlike the constant outer protection, and sealed upper surface around a tart.

In the United Kingdom, there is an exemption in place allowing custard tarts made with eggs to be left out at room temperature for 24 hours, indicating a different perceived risk for these food items between the two jurisdictions. One possible explanation for this is differences in their egg providers. In the United Kingdom, there are vaccine programs in place for laying poultry flocks to help prevent the transmission of non-typhoidal *Salmonella* (O'Brien, 2013). This vaccination program was prompted by a large *Salmonella* epidemic in the early '90s and has since caused a significant decline in the incidences of non-typhoidal *Salmonella* in humans (O'Brien, 2013). A study from the United Kingdom examined pooled raw shelled egg mix for *Salmonella* contamination in hundreds of food service establishments and found only one contaminated sample, suggesting that there are low rates of *Salmonella* contamination (Gormley et al., 2010). In Australia, non-typhoidal *Salmonella* is the country's second leading notifiable cause for gastroenteritis, being linked to many outbreaks from chicken meat and eggs (Fearnley et al., 2011). A study looking at human *Salmonella* infections found that although a great deal of the chicken was contaminated with *Salmonella*, no egg contents were contaminated, only a small portion of outer egg

Table 2. Characteristics of Portuguese custard tart bakeries in Toronto

Bakery	Estimated tarts produced per week	Estimated days to sell a fresh batch of tarts	Age of tarts when collected (approx. hours)	Storage location of tarts being sold	The temperature custard tarts are cooked (°C)	Do the ingredients include egg?
A	1,400	1	2	Refrigerator	315.5	Yes
B	5,000	1	25	Covered at room temperature	315.5	Yes
C	12,000	1	4.8	Refrigerator	343.3	Yes
D	20,000	1	1	Refrigerator	332.2	Yes
E	140,000*	1	8.5	Refrigerator	371.1	Yes
F	0†	n/a	n/a	Refrigerator	n/a	Yes
G	5,000	1	8.75	Covered at room temperature	343.3	Yes
H	4,000	1	5.8	Refrigerator	315.5	Yes
I	1,000	2	53	Refrigerator	343.3	Yes
J‡	No data	No data	No data	Uncovered at room temperature	No data	No data
K	2,000	1	2.3	Refrigerator	265.5	Yes
L	7,000	2	30.8	Covered at room temperature	287.7	Yes
M	0†	n/a	n/a	Refrigerator	n/a	Yes
N	1,500	1	3.3	Refrigerator	343.3	Yes

*Tarts produced include those being frozen and shipped to major grocery chains as private label products.

†Tarts not produced on site they are shipped in from a larger distributor, making some data not applicable.

‡Baker was unavailable and staff unwilling to answer questionnaire. Storage of tarts was observed in the bakery.

shells (Fearnley et al., 2011). In both studies, the risk associated with *Salmonella* in eggs was low; however, only poultry flocks in the United Kingdom receive vaccinations (O'Brien, 2013).

In Ontario, a case-control study looking at the risk factors associated with *Salmonella* Enteritidis found chicken consumption and poor hand hygiene of poultry products were high-risk activities, while preparing food items with raw egg had a very low risk (Middleton et al., 2014). This study does not dismiss the risk of *Salmonella* infections from eggs in food items, such as Portuguese custard tarts, but highlights the risk may not be as great as other products (i.e., chicken), especially if safe food handling practices are followed. Another study in British Columbia found an emergence of human cases of *Salmonella* Enteritidis from 2008 to 2010 linked to egg consumption, with the odds of egg consumption 2.4 times higher among cases than controls (Taylor et al., 2012). The study found that many food service establishments were illegally using ungraded eggs (Taylor et al., 2012). This study highlights the importance of ensuring bakeries are using graded eggs to prepare custard tarts to reduce any associated risk from egg sources.

The results of this study illustrate how custard tarts have the potential to support microbial growth, since the water activity is high and the pH is neutral; however, none of the sampled tarts were contaminated with *S. aureus*, *E. coli*, or coliforms. Further studies are needed to determine longevity of custard tart safety at room temperature, the potential presence of other microbial contaminants not included in this study, and to provide a larger

sample size for evaluation. In conclusion, the results of this study suggest the baking process, self-contained custard, and the dry surface area of a Portuguese custard tart prevents the growth of pathogens, making the tarts safe to store at an ambient temperature.

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References

- Barnes, G. H., and Edwards, A. T. 1992. An investigation into an outbreak of *Salmonella* Enteritidis phage-type 4 infection and the consumption of custard slices and trifles. *Epidemiol. Infect.* **109**(3): 397–403. doi: 10.1017/S095026880005038X
- Evans, M. R., Tromans, J. P., Dexter, E. L., Ribeiro, C. D., and Gardner, D. 1996. Consecutive *Salmonella* outbreaks traced to the same bakery. *Epidemiol. Infect.* **F116**(2): 161–167. doi: 10.1017/S0950268800052390
- Fearnley, E., Raupach, J., Lagala, F., and Cameron, S. 2011. *Salmonella* in chicken meat, eggs and humans; Adelaide, South Australia, 2008. *Int. J. Food Microbiol.* **146**(3): 219–227. doi: 10.1016/j.ijfoodmicro.2011.02.004

- Gormley, F. J., Little, C. L., Murphy, N., de Pinna, E., and McLauchlin, J. 2010. Pooling raw shell eggs: *Salmonella* contamination and high risk practices in the United Kingdom food service sector. *J. Food Prot.* **73**(3): 574–578. doi: 10.4315/0362-028X-73.3.574
- Middleton, D., Savage, R., Tighe, M. K., Vrbova, L., Walton, R., Whitefield, Y., Varga, C., Lee, B., Rossella, L., Dhar, B., et al. 2014. Risk factors for sporadic domestically acquired *Salmonella* serovar Enteritidis infections: A case-control study in Ontario, Canada, 2011. *Epidemiol. Infect.* **142**(7): 1411–1421. doi: 10.1017/S0950268813001945
- New South Wales Food Authority. 2008. Potentially hazardous foods. NSW Food Authority, Newington, NSW.
- O'Brien, S. J. 2013. The “decline and fall” of non-typhoidal *Salmonella* in the United Kingdom. *Clin. Infect. Dis.* **56**(5): 705–710. doi: 10.1093/cid/cis967
- Ontario Agency for Health Protection and Promotion (Public Health Ontario). 2013. Public health inspector's guide to the principles and practices of environmental microbiology. 4th ed. Queen's Printer for Ontario, Toronto, ON.
- Taylor, M., Leslie, M., Ritson, M., Stone, J., Cox, W., Hoang, L., and Galanis, E. 2012. Investigation of the concurrent emergence of *Salmonella* Enteritidis in humans and poultry in British Columbia, Canada, 2008–2010. *Zoonoses Public Health.* **59**(8): 584–592. doi: 10.1111/j.1863-2378.2012.01500.x
- U.S. Food and Drug Administration (FDA). (2014). Evaluation and definition of potentially hazardous foods – Chapter 4. Analysis of microbial hazards related to time/temperature control of foods for safety. Available at: <http://www.fda.gov/Food/FoodScience-Research/SafePracticesforFoodProcesses/ucm094147.htm> [accessed 10 March 20116]