

Introduction

What is Kitfo?

- A traditional Ethiopian dish made from minced lean beef, clarified butter and a mixture of spices known as "mitmita," with additional ingredients often including Ethiopian cardamom or "korarima," coriander, garlic, salt and pepper. The dish is served with flatbread and cottage cheese.
- Although it may be consumed well done or medium cooked "lebleb," it is commonly only warmed to room temperature and served raw.

What are the health concerns?

- Kitfo is often served raw and appears not to have a method for the killing of bacteria that frequently contaminate meat.
- Similar raw meat dishes such as steak tartar and kibbeh nayyeh have been implicated in numerous outbreaks of foodborne illness caused by *Salmonella Typhimurium* and *E. coli* O157:H7.
- Studies on steak tartar and kibbeh nayyeh in Toronto have shown these dishes to have unsatisfactorily high bacterial counts.
- Microbiological assessments of kitfo in Ethiopia have also revealed elevated bacterial counts, however no assessments have previously been conducted on kitfo served in Canada.

What are the legal concerns?

- Raw meat products are considered Ready-To-Eat as they do not require further processing before consumption.
- Food products must be subjected to a process sufficient to destroy pathogenic bacteria (O.Reg 493/17).
- It is unclear whether or not kitfo complies with the food safety regulation.

Objectives

It is hypothesized that, like other raw meat dishes served in Toronto, kitfo may be contaminated with bacteria posing a risk of foodborne illness. The objectives of this study were:

- To determine the microbiological safety of kitfo served in Toronto using *E. coli* and total coliforms as indicator organisms.
- To investigate food preparation and handling parameters that may affect kitfo's microbiological safety.
- To make recommendations on possible ways of improving the safety of kitfo and other raw meat dishes served in the city.



Methods

- 22 restaurants serving kitfo were identified, of which 14 agreed to participate in the study.
- At each location chefs were asked to prepare 50g samples of raw and medium cooked kitfo and to clarify what ingredients were added, whether it was ground by hand or by machine, whether kitfo was made in advance or to order, whether or not all chefs who prepared kitfo were certified and whether or not the premise followed a Hazard Analysis and Critical Control Point (HACCP) or HACCP-like plan.
- Temperatures were measured before and after preparation by the primary investigator and samples were aseptically collected into labeled sampling bags.
- All samples were stored in a cooler kept below 4°C and delivered to the National Microbiology Laboratory at the University of Guelph for *E. coli* and total coliform enumeration.
- Results were compared to Health Canada's Microbiological Guidelines for Ready-To-Eat Foods. Unsatisfactory cut-off values were ≥ 100 CFU/g for *E. coli* and ≥ 1000 CFU/g for total coliforms.

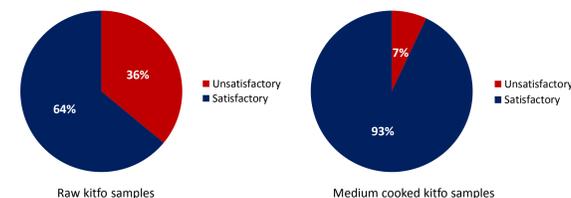
Results

Restaurant	Kitfo raw		Kitfo medium cooked		Temperature (°C)		
	<i>E. coli</i> (CFU/g)	Total coliforms (CFU/g)	<i>E. coli</i> (CFU/g)	Total coliforms (CFU/g)	Storage	Kitfo Raw	Kitfo Medium cooked
1	0	2.0×10^1	0	0	5	27	35
2	1.9×10^2	9.0×10^2	2.4×10^2	1.0×10^3	10	20	27
3	9.0×10^1	1.1×10^3	0	0	11	33	40
4	1.0×10^1	2.2×10^3	0	2.0×10^1	10	27	35
5	0	3.3×10^3	0	0	11	35	69
6	0	0	0	0	4	59	71
7	0	1.6×10^2	0	1.0×10^1	16	43	51
8	1.0×10^1	4.6×10^2	0	0	9	36	88
9	0	9.0×10^1	0	0	5	27	80
10	0	0	0	1.0×10^1	10.8	43	58
11	0	5.0×10^1	0	0	0	39	52
12	0	4.2×10^1	0	0	14.5	33	61
13	0	1.1×10^2	0	1.0×10^1	13	27	54
14	6.0×10^1	2.1×10^2	0	0	0	48	81

Table 1. *E. coli* and total coliform counts by restaurant number and type of sample, along with beef temperature readings before and after preparation.

Restaurant	Meat grinding	Equipment cleaning frequency	All chefs certified	Kitfo made to order or in advance	HACCP or HACCP-like plan
1	Pre-ground	-	no	to order	no
2	Pre-ground	-	yes	to order	no
3	Pre-ground	-	yes	to order	no
4	Pre-ground	-	yes	to order	no
5	On-site - machine	After every use	no	to order	no
6	Pre-ground	-	no	to order	no
7	On-site - machine	After every use	no	to order	no
8	Pre-ground	-	no	to order	no
9	On-site - by hand	After every use	yes	to order	no
10	Pre-ground	-	no	to order	no
11	On-site - machine	After every use	yes	to order	no
12	On-site - machine	After every use	no	to order	no
13	Pre-ground	-	yes	to order	no
14	Pre-ground	-	yes	to order	no

Table 2. Kitfo preparation and handling parameters.



Correlation Analysis

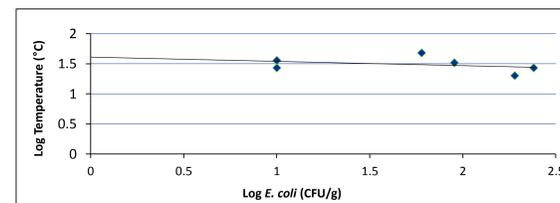


Figure 1. Log Temperature vs. log *E. coli* count of all positive samples. Spearman correlation $r = -0.443$

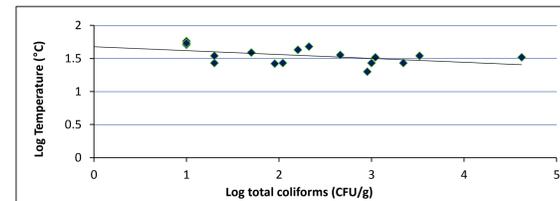


Figure 2. Log Temperature vs. log total coliforms count of all positive samples. Spearman correlation $r = -0.469$

Discussion

Microbiological Counts

- 21% of all samples were unsatisfactory according to Health Canada guidelines (Table 1). This is less than previously studied Ethiopian kitfo (100%), Torontonian steak tartar (92%) and Torontonian kibbeh nayyeh (70%).
- Fewer unsatisfactory samples were found in the medium cooked group than the raw group suggesting medium cooked kitfo may be safer.
- Unsatisfactory counts of *E. coli* and total coliforms were found in both kitfo groups suggesting pathogens may be present in either type.

Temperature Data

- Increasing temperature was correlated with decreasing counts of both *E. coli* (Figure 1) and total coliforms (Figure 2) but average temperatures were not high enough in raw (35.5°C) or medium cooked (57.3°C) kitfo to meet the recommended 71°C for the destruction of pathogens.
- Average meat storage temperature was 8.5°C, suggesting temperature abuse at many restaurants. Meat storage temperature should be ≤ 4 °C.

Preparation and Handling Parameters

- Increase in unsatisfactory samples was not associated with meat grinding practices, chef certification, kitfo being made to-order or the presence of a HACCP plan (Table 2).
- A trend was seen where no samples ground on-site had *E. coli*. This suggests grinding meat on-site may be safer than purchasing pre-ground meat as it goes through fewer processing steps, comes from a single animal and may be less likely to be contaminated.
- No additional ingredients were associated with increases in unsatisfactory samples suggesting the lack of any protective effects from "mitmita" and "korarima," which have bactericidal properties.
- Some lapses in good manufacturing practices were noted, suggesting that bacterial contamination may not come from the meat cuts alone.

Conclusions

- Both raw and medium cooked kitfo served in Toronto, Ontario are contaminated with unsatisfactory levels of bacteria and pose a risk of foodborne illness. Medium cooked kitfo is slightly less contaminated than raw kitfo.
- Chef certification, HACCP implementation and additional ingredients appear not to impact kitfo contamination levels.
- Restaurants may improve the safety of kitfo with adequate temperature control, good manufacturing practices and grinding meat on-site.
- On-site warnings should be considered to inform the public of the risks of consuming kitfo. This would be particularly beneficial for the protection of vulnerable populations such as children, the elderly, pregnant women and the immunocompromised.



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References

- Abdul-Muhsen, H. (2018). Microbiological Quality of Steak Tartare in Toronto, Ontario. Poster presentation at the School of Occupational and Public Health Student Research Symposium: April 2018, Toronto, Ontario.
- Adegoke, G. O., Ewievurhoma, F. O., & Afolabi, M. O. (2016). African cardamom (*Alfomum daniellii*) oils. In *Essential Oils in Food Preservation, Flavor and Safety* (pp. 163-171). Academic Press. Retrieved from <https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/alfomum>
- Centers for Disease Control and Prevention. (2013). Multistate outbreak of *Salmonella* Typhimurium infections linked to ground beef (final update). Retrieved from <https://www.cdc.gov/salmonella/typhimurium-01-13/index.html>
- Health Canada. (2010). Microbial Guidelines for Ready-to-Eat Foods - A Guide for the Conveyance Industry and Environmental Health Officers (EHO). Retrieved from http://publications.gc.ca/collections/collection_2014/sc-hc/H164-167-2013-eng.pdf
- Health Canada. (2014). Health Canada's Guidance on Safe Cooking and Handling Labelling for Raw Ground Meat and Raw Ground Poultry. Retrieved from <https://www.canada.ca/en/health-canada/services/food-nutrition/regulation-guidelines/guidance-documents/guidance-safe-cooking-handling-labelling-ground-meat-ground-poultry-2014.html>
- Health Promotion and Protection Act: Regulation 493/17 Food Premises, Revised Regulations of Ontario (1990). Retrieved from <https://www.ontario.ca/laws/regulation/170493R8K40>
- Gaulin, C., Ramsay, D., Catford, A., & Bekal, S. (2015). Escherichia coli O157: H7 outbreak associated with the consumption of beef and veal tartares in the province of Quebec, Canada, in 2013. *Foodborne pathogens and disease*, 12(7), 612-618. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/27005472>
- Kanaan, M., Meldrum, R., Tustin, J., Young, I., & MacDonald, C. (2018). Microbial Analysis of Middle-Eastern Raw Ready-To-Eat Beef Dish Kibbeh, Nayyeh. Poster presentation at the Canadian Institute of Public Health Inspectors (CIPIH) Ontario Annual Educational Conference 2017: September 2017, Mississauga, Ontario.
- Teggegne, M., & Ashenafi, M. (1998). Microbial Load and Incidence of *Salmonella* Spp. in 'Kitfo', a Traditional Ethiopian Spiced, Minced Meat Dish. *The Ethiopian Journal of Health Development*, 12, 135-140. Available from: ehd.org/index.php/ehd/article/view/947/702. University of Guelph Centre for Public Health and Zoonoses. (2011). Steak tartare. Retrieved from <http://cpbaz.ca/wp-content/uploads/2017/11/Fact-Sheet-Steak-Tartare-March-14-Update.pdf>
- Woldeab, B., Regassa, R., Alemu, T., & Megersa, M. (2018). Medicinal plants used for treatment of diarrhoeal related diseases in Ethiopia. *Evidence-Based Complementary and Alternative Medicine*, 2018. Retrieved from <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5878875/>