Microbiological quality of fermented rice and kimchi produced in Toronto restaurants

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Introduction

Kimchi is a common and popular fermented side dish served in many Korean restaurants. Due to its commonality in Korean culture, there are many different variations of products considered kimchi. Some common ingredients found in kimchi include: Napa cabbage, Korean red pepper flakes, salt, sugar, green onions, garlic and ginger. Many restaurants that serve Korean foods, typically also make their own kimchi.

Fermented rice is another ready-to-eat fermented food product found within Asian cuisine. The method of fermented rice production varies by country and region. In China, steamed rice and yeast balls are typically used, while in the Philippines, steamed rice, large quantities of salt, and sometimes fish are used in making fermented rice. This food product, regardless of regional variation, will be fermented and cooked, producing the final fermented product.

The public health concern with these food products is whether the process of fermentation has been carried out successfully. Fermentation typically results in an increase in lactic acid bacteria in the food products, which can in turn inhibit bacterial growth.[1] Improper fermentation may result in the growth of pathogenic bacteria due to the favorable growing conditions of improperly handled fermentations.[1]

Objective

The objective of this study is to determine if these ready-to-eat fermented foods are safe for consumption. It will also provide a basis for further research on the safety of fermented food products.

Methods

Step 1

- Locate restaurants that make fermented rice or kimchi on premise.

Step 2

- Visit restaurant with a Toronto Public Health Inspector and interview manager or cook on how the food product is made and safe food handling practices.

Step 3

- Collect two 250 mL samples of the food product immediately after the interview, and store or transport at 4°C.[2]

Step 4

- Deliver samples to Maxxam analytics within 24 hours for testing of Total Coliforms and *Escherichia coli.*

Step 5

- Analyze test results and refer back to Health Canada's Microbial Guidelines for Ready-to-Eat Foods to determine microbiological quality. [2]

Table 1: Health Canada's Microbial Guidelines for Ready-to-Eat Foods limits[3]

	Total Coliforms (cfu/g)	*Escherichia coli* (cfu/g)
Satisfactory	<100	<10
Marginal	<1000	<100
Unsatisfactory	≥ 1000	≥ 100

Results

- A total of 7 restaurants were interviewed about how the food product was made and safe food handling knowledge.
  - 5/7 restaurants stated that the person who makes the food product is a certified food handler.
  - 1/7 used glass containers, 2/7 used plastic containers, 2/7 used metal containers and 1/7 used both plastic and metal containers (1 restaurant did not state type of container used).
  - 3/4 kimchi restaurants stored the kimchi in the refrigerator.
  - 3/3 restaurants that produced fermented rice cooked the final product before packaging.
  - 2/3 restaurants fermented the rice in the refrigerator.
- A total of 14 samples were taken from restaurants that made kimchi and fermented rice products on the premises.
  - 12 of the samples were kimchi.
  - 2 of the samples were fermented rice.
- Kimchi tested for total coliforms:
  - 4/12 samples tested negative.
  - 5/12 samples tested positive within marginal limits.
  - 3/12 samples tested positive with results deemed as hazardous.
- No samples of fermented rice tested positive for total coliforms.
- No samples of kimchi or fermented rice tested positive for Escherichia coli.
  - 3 samples of kimchi were reported to have overgrowth.

Table 2: Each food sample and its corresponding fermentation

Food Type	Location	Length of fermentation
Kimchi	1	1-1.5 hours
	2	eaten right away
	3	eaten right away
	4	N/A
Fermented Rice	1	15 days
	2	1-2 weeks
	3	4 weeks

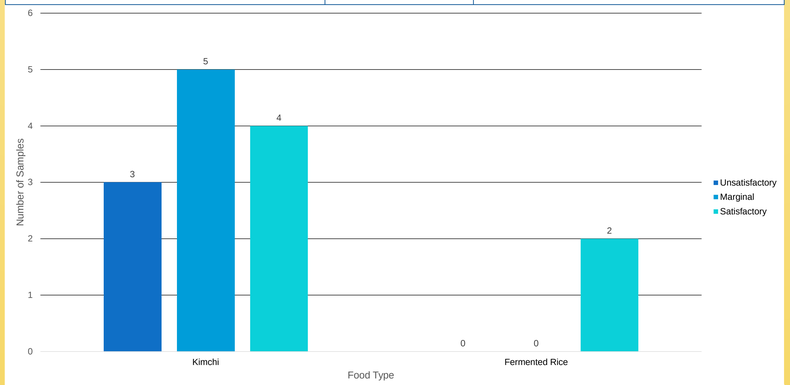

Figure 1: Food type based on Total Coliform test results

Discussion

- Test results were compared to Health Canada's *Microbial Guidelines for Ready-to-Eat Foods.*[2]
- The reportable detection limit for Total Coliforms and *E.coli* is 10 cfu/g (any results <10 cfu/g were deemed negative for total coliforms or *E.coli*).
- Based on the results of this study 3/12 production methods produced unsatisfactory bacterial counts and were considered contaminated.[3]
- 5/12 samples had bacterial counts were marginal but below a level of concern. However, these were still high enough to suggest hygiene issues.[3]
- While all fermented rice and kimchi tested negative for *E.coli*, 3 kimchi samples resulted in low counts due to overgrowth suggesting there may have been high levels.
- A food study on bacterial survival in fermented alcoholic beverages found that the longer the food product stayed in storage, the higher the likelihood that the bacterial levels would decrease and be completely eliminated.[4]
- Another food study on *Mycobacterium bovis* survival in fermented milk found that inactivation of the bacteria was not ensured unless the fermentation process was greater than 24 hours.[5]
- Contamination of food products may imply improper fermentation due to significantly low fermentation time of some kimchi products. It may also imply poor food handling or temperature abuse during food production or storage.

Limitations

- 4 samples of fermented rice were unable to be tested due to the lack of food products available during sampling period.
- Few locations in total produced the food product, or access to location was denied which resulted in a small sample size.
- Language barriers were an issue for some interview locations, and therefore some details may be missing from production methods.

Conclusion

A larger number of samples than expected tested positive for total coliforms, which may imply incomplete fermentation of the food product or improper handling. This study suggests that kimchi may be a food product of concern, and a potential health risk to consumers. Further research is needed to validate these findings in a larger proportion of samples.

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