Research Project Proposal for Graduation with Research Distinction

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***Major*:** Food Science & Technology

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***Title*:** Examining Growth Patterns of Starter Cultures in Swiss Cheese.

Introduction

One major difference between Swiss cheese production and other types of cheeses is the number of bacterial starter cultures (1). Often, most cheese productions involve utilization of one or two bacteria. However, the Swiss cheese production involves active fermentation of three different bacteria. Specifically, Swiss cheese production involves two main flora, thermophilic lactic acid bacteria (LAB) such as *Streptococcus thermophillus* and *Lactobacillus* spp. and propionic acid bacteria (PAB), *Propionibacterium freudenreichii* (2). These microorganisms play specific roles in the development of the sweet and nutty flavor, eye-production, and texture of Swiss cheese. Understanding the growth of these species is important because their growth and metabolism are directly associated with their fermentation. Specifically, byproducts of their fermentation such as lactic acid, carbon dioxide, and volatile organic compounds are highly linked with quality of Swiss cheese (3). Lactic acid and carbon dioxide play crucial roles in the Swiss cheese production. Lactic acid produced by LAB feeds PAB, which in turn produces propionic acid and carbon dioxide. Then, carbon dioxide from PAB creates the holes, the “eyes” in Swiss cheese (3). In addition, volatile organic

compounds contribute to odor and flavor of Swiss cheese (4). Thus, understanding growth patterns of LABs and PAB during the manufacture of Swiss cheese is important. Analyzing growth patterns of these starter cultures could help further studies to identify what specific compounds are produced at specific manufacturing stages and to analyze how ripening of Swiss cheese is affected by the interactions between LABs and PAB.

Materials and Methods

For this particular research project, samples from two Ohio-based factories at four different manufacturing stages (out of press, pre-cool, warm-room, and at cheese cutting) were obtained. Then, samples were homogenized with 2% sodium citrate as a diluent for the enumeration purpose. Then, 0.1% peptone water was used for serial dilutions, followed by spread-plating on agar media. Rogosa SL agar, M17 agar, and lithium glycerol agar were used for *Lactobacillus spp., Streptococcus thermophilus,* and *Propionibacterium freudenreichi*, respectively. Then, plated M17 and lithium glycerol agars were incubated anaerobically at 37ºC for 3~5 days whereas plated Rogosa SL agar was incubated anaerobically at 30ºC for 3~4 days. Once the incubation period was over, colony forming units (cfu) /g was calculated in order to estimate the populations of each starter culture. Cfu/g of each sample was calculated using the following equation: [(number of colonies) / (dilution factor)*(volume plated on agar)].

Results

In terms of growth of *Lactobacillus* spp., Company A showed a slight decline in growth, but its growth was not statistically different (Fig 1). On the other hand, Company B showed highest growth at the after press stage and its growth was not statistically different after (Fig 1).

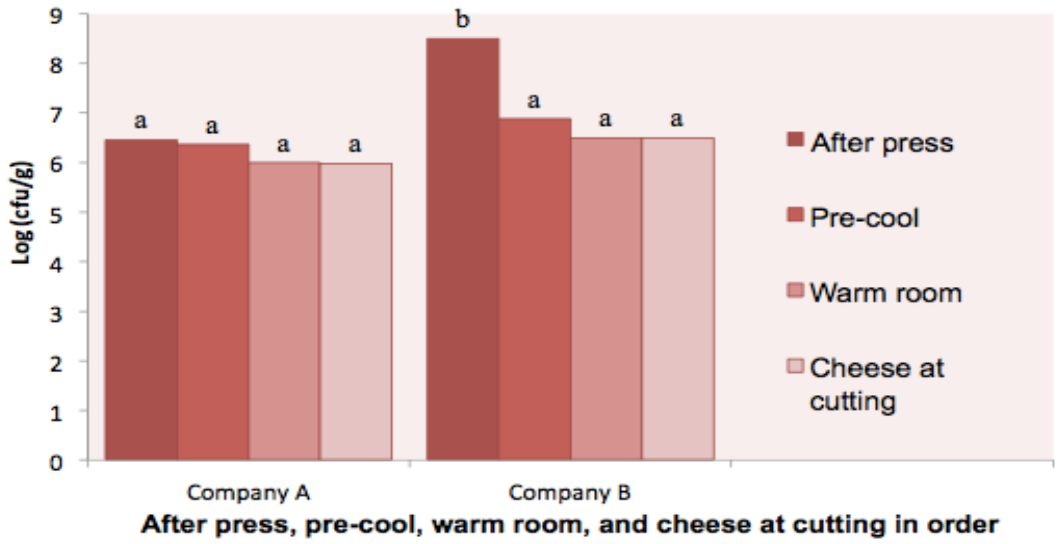

Figure 1. Comparison of growth patterns of *Lactobacillus* spp. at after press, pre-cool, warm room, and cheese at cutting stages between companies.
[a-b] Different letters indicate significant differences between processes

Growth of *S. thermophilus* from company A showed no statistical variance until the cheese at cutting stage whereas *S. thermophilus* from company B showed a decline after after-press stage and remained statistically similar (Fig 2).

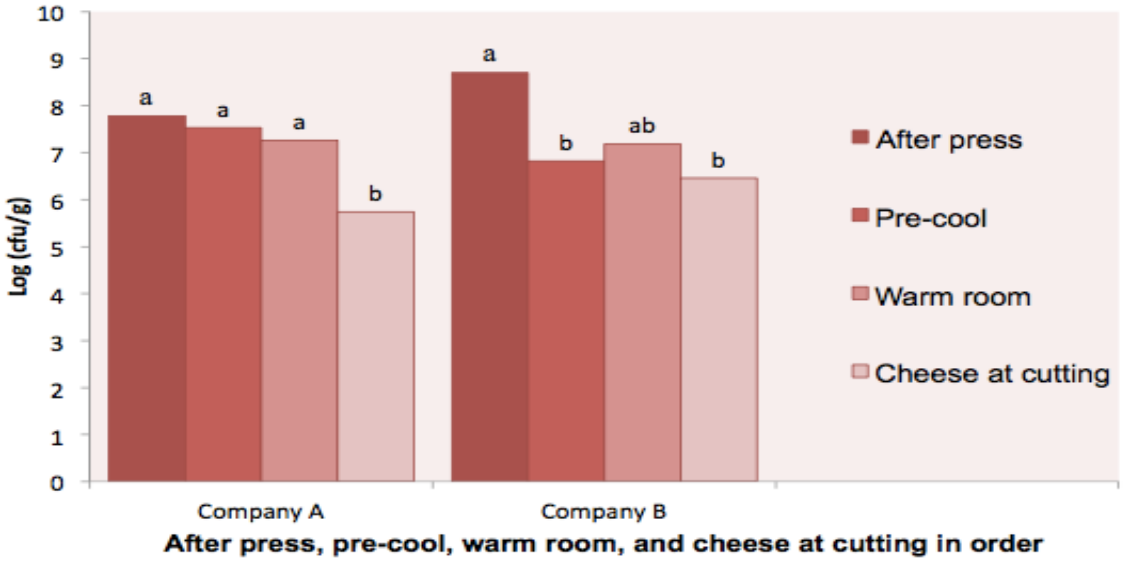

Figure 2. Comparison of growth patterns of *S. thermophilus* at after press, pre-cool, warm room, and cheese at cutting stages between companies.
[a-b] Different letters indicate significant differences between processes

For company A, growth of *P. freudenreichi* was highest at the after press stage and its growth declined gradually (Figure 3). For company B, the highest growth was seen at the pre-cool and warm room stages (Figure 3).

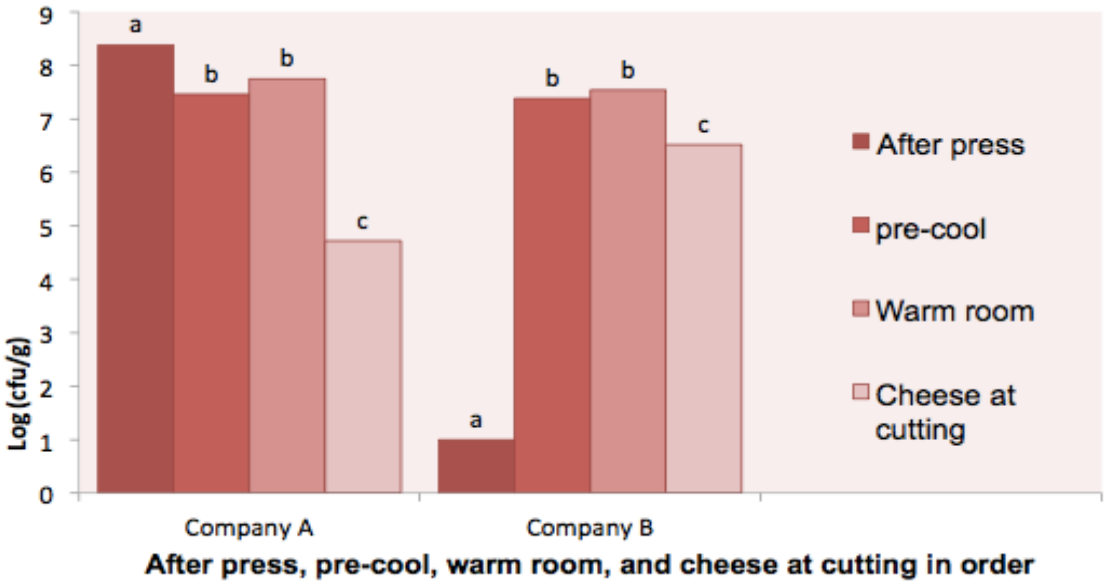

Figure 3. Comparison of growth patterns of *P. freudenreichi* at after press, pre-cool, warm room, and cheese at cutting stages between companies.
[a-c] Different letters indicate significant differences between processes

Conclusions

Growth patterns of each species between Company A and B differed slightly. Specifically, the major variance was found in the growth profiles of *P. freudenreichi*. Different growth profiles of starter cultures observed from this study could contribute to each company's distinctive flavor, aroma, or texture of Swiss cheese.

Future Directions

The results obtained from this study could potentially guide further study to measure byproducts of fermentation of each bacterium and analyze how they might contribute to the ripening or flavor development of Swiss cheese.

References

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