Microbial Risk Factors Associated With Condensation In Ready-To-Eat Processing Facilities

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ABSTRACT

Processing plant environments are conducive to the accumulation of condensation on various surfaces, which can drip directly into food or food contact surfaces. Recently, the USDA has asked processors to address condensation in the HACCP plan; however, there is a lack of data describing the actual microbial risk associated with it. The objectives of this study were to determine the microbial risk associated with condensation in Ready-to-Eat (RTE) processing environments and to identify controllable risk factors associated with condensation formation. A minimum of 30 samples pre-operational and 30 samples during operation were collected from areas of visible condensation, overhead pipes and dripping pans in 3 RTE meat processing plants each season during a one-year period. Samples were weighed to quantify actual amounts of condensation present, after which samples were subjected to enumeration of Total Plate Counts, *Enterococci*, *E. coli*, yeast and molds and detection of *Listeria* spp. Total aerobic plate counts ranged from non-detectable to 2.5 $\log_{10}$ cfu/ml with most samples containing less than100 cells/ml. The vast majority of samples did not contain any detectable *E. coli* or Enterococci. Yeast and mold counts were less than 1.0 $\log_{10}$ cfu/ml in all samples. *Listeria* spp was only detected in 3 samples of more than 600 that were analyzed. All were detected in operational samples. Data from this project will help processors to make science-based decisions on the risks associated with condensation in RTE plants and to establish CCP or monitoring methods needed in the HACCP plan.

INTRODUCTION

Over the past several years condensation has caused numerous problems for meat processors, as the processing plant environment is conducive to the accumulation of condensation on various surfaces in slaughter areas, fabrication areas, and ready-to-eat areas. Condensation is usually formed on a non-meat contact surface that is not subjected to the same sanitation protocols as the meat contact surfaces. When condensation occurs, the condensate can drip onto the fresh meat surfaces. This results in indirect contact between non-meat and meat surfaces. According to the USDA, when this occurs, the area that comes in contact with the condensation should be trimmed. Unless the processor or inspector sees the condensation drip onto the meat, it is virtually impossible to find the area that needs to be trimmed thus posing an additional challenge to the processor.

In ready-to-eat processing areas, *Listeria monocytogenes* persists in the plant environment and could possibly be transferred from an environmental area to the finished product through condensation. Even though condensation frequently occurs and it can result in indirect contact between non-meat and meat surfaces, there is currently no evidence that condensation results in an increased food safety risk to the consumer. In other words, condensation is assumed to be a hazard yet no scientific data support this fundamental assumption.
Data obtained from this project will provide information concerning:
1) Microbial quality of condensate by bacterial type;
2) Risk factors for condensate formation; and
3) If bacteria are recovered, genotype dominance within and over time

OBJECTIVES

The objectives of this study are to:
1) Determine the microbial risk associated with condensation; and
2) Determine if the presence of condensation in meat processing facilities pose additional risks when present during operation and before operation

MATERIALS AND METHODS

Slaughter, fabrication, and ready-to-eat processing plants across the Southwest and Midwest (US) were included in this study. Each plant was visited 4 times over a 1-year period in order to collect samples during each season. A total of 3000 samples were collected.

Sample Collection: Condensation samples were collected throughout the slaughter, hot box, fabrication and RTE areas in each plant. Condensation locations included walls, windows, ceilings, overhead structures, pipes, drip pans, catwalks, hand rails, cooler units, air ventilation systems, fans, drip pans, doors, conveyor belts, frames, guards, ladder racks, electrical boxes, panels, machinery (such as slicing, peeling, packaging in RTE areas) and any other location of historical condensation as described by plant personnel.
Sterile SpongeSicles® were used to collect the condensation and weighed before and after collection to quantify the actual amount of condensation present.
Microbiological analysis were conducted on each sample using standard microbiological protocols. Each condensation sample was tested and enumerated for Total Plate Counts, *Enterococci*, *E. coli*, *Salmonella* spp., and *Listeria* spp. Confirmed isolates were subjected to fingerprinting (PFGE) to compare microbial profiles for each area (data not shown).

RESULTS AND DISCUSSION

Ready-to-Eat Areas

Samples collected in ready to eat processing facilities during operation contained few total aerobic bacteria and coliforms (Fig 1 and 2). Numbers are less than zero because when the total amount of bacteria present in the total amount of condensation collected was adjusted to the amount present in the condensation per ml, the amount was generally less than one bacterial cell per ml resulting in negative log numbers.Practically no coliforms were collected in the condensation from any of the ready to eat operational samples.

In pre-operational samples the total aerobic organisms detected was less then 2.5 $\log_{10}$ cfu/ml (Figure 3). All coliform counts were less than 1 cell detected per ml of condensation (Figure 4).

Fabrication Areas

In fabrication areas during operation, there appears to be a peak in all three processing plants in the amount of total aerobic organism collected during the winter with total numbers detected to be around 2.5-3.5 $\log_{10}$ cfu/ml of condensation (Figure 5). All other sampling times resulted in less than one cell detected/ml of condensation. Few coliforms were detected in the samples (Figure 6).

Following a trend similar to the observations made in the RTE areas, the total amount of aerobic bacteria collected in fabrication areas was less than 2.0 $\log_{10}$ cfu/ml of condensation during pre operations(Figure 7). Few coliform bacteria were detected as well (Figure 8).

Slaughter Areas

Condensation samples collected in slaughter areas during processing contained few aerobic bacteria (Figure 9). Most samples contained less than one bacterial cell per ml of condensation. In plant number 2, in the winter we observed the highest amount of total aerobic bacteria. In the summer in plant #3 and in the spring in plant #1 we collected around 1.5-2.0 $\log_{10}$ cfu/ml which is still very low. All coliform counts were less than 1 cell per ml of condensation (Figure 10).

The total aerobic bacteria collected in slaughter areas prior to operation was less than 2.0 $\log_{10}$ cfu/ml of condensation (Figure 11). All coliform counts in pre-operational ready to eat areas were less than 1 bacterial cell/ml (Figure 12).

Salmonella and Listeria spp

Of all the samples collected during both operation and pre-operation, only 2 samples were positive for the presence of Salmonella. These samples were collected from a beef slaughter area where there was high traffic. Only one sample in a ready-to-eat area tested positive for the presence of *Listeria* spp. This sample was collected on the raw side of the ready-to-eat area and not the cooked side

In all facilities and all seasons, there was less than one coliform cell detected/ml of condensation in the plant. Similarly, there were few aerobic bacteria present in the samples. Samples were collected from environmental areas and from processing

equipment and the presence of some aerobic bacteria is to be expected. The numbers were very low. There were no seasonality differences in the amount of condensation present in this study. Additionally. The amount of bacteria present was similar in slaughter, fabrication and ready-to-eat areas in both pre-operational and operational samples. Additionally, the amount of bacteria detected was similar among all plants participating in this study indicating that data are likely applicable to a number of different operations.

REFERENCES

Food Safety and Inspection Service (USDA). FSIS directive 11,000.1 Notice 31-98 -- Condensation Policy. Sanitation Requirements for Official Meat and Poultry Establishments. September 10, 1998. Washington, D.C.

ACKNOWLEDGEMENT

This project was funded by the American Meat Institute Foundation

Results and Discussion

Figure 1. Total Aerobic Plate Counts in Condensation Samples Collected in Ready to Eat Processing Facilities During Operation

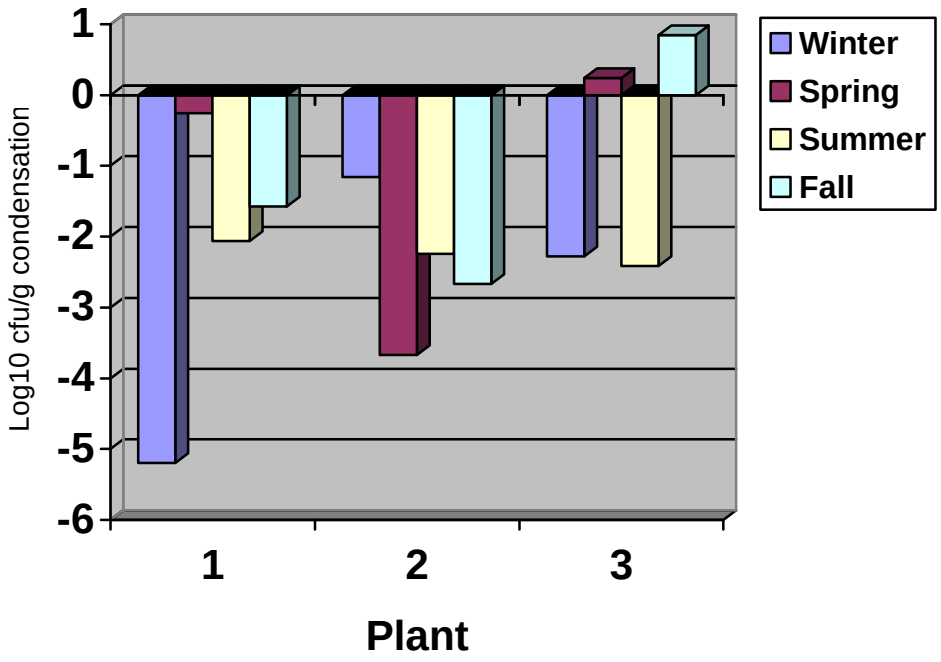
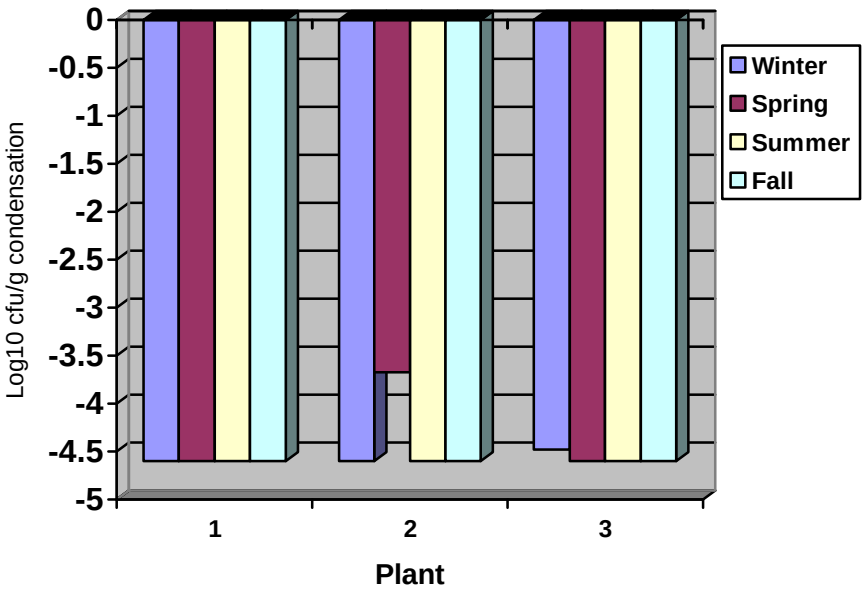


Figure 2. Total Coliform Counts in Condensation Samples Collected in Ready to Eat Processing Facilities During Operation



Samples collected in ready to eat processing facilities during operation contained few total aerobic bacteria and coliforms (Fig 1 and 2). Numbers are less than zero because when the total amount of bacteria present in the total amount of condensation collected was adjusted to the amount present in the condensation per ml, the amount was generally less than one bacterial cell per ml resulting in negative log numbers. In plant 3, the total aerobic plate counts were not negative in the spring and fall, however the amount present was still less than 1.0 $\log_{10}$ cfu/ml of condensation. Practically no coliforms were collected in the condensation from any of the ready to eat operational samples.

Figure 3. Total Aerobic Plate Counts in Condensation Samples Collected in Slaughter Facilities During Operation

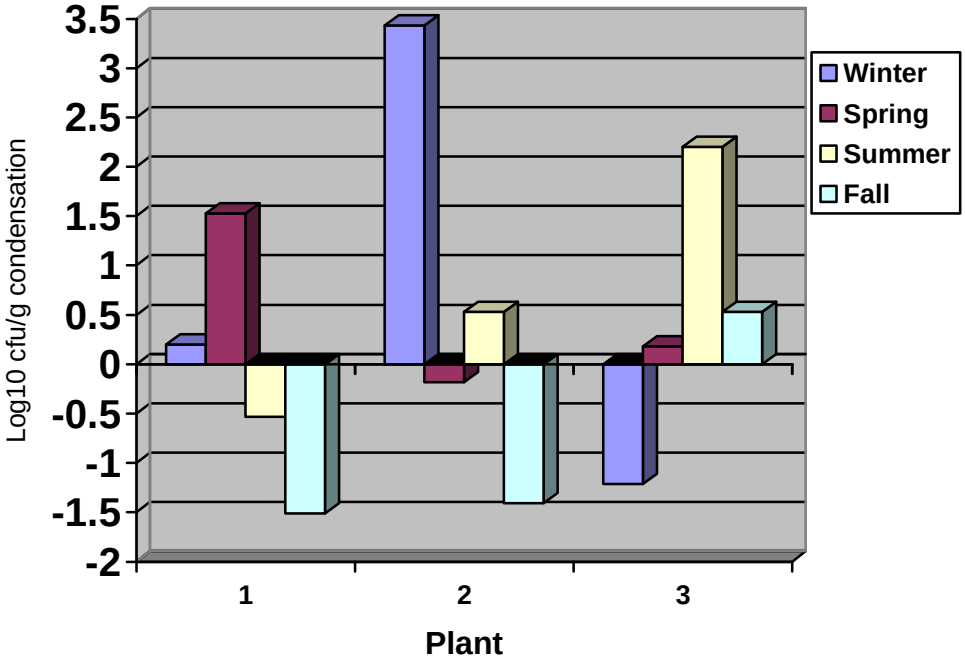


Figure 4. Total Coliform Counts in Condensation Samples Collected in Slaughter Facilities During Operation

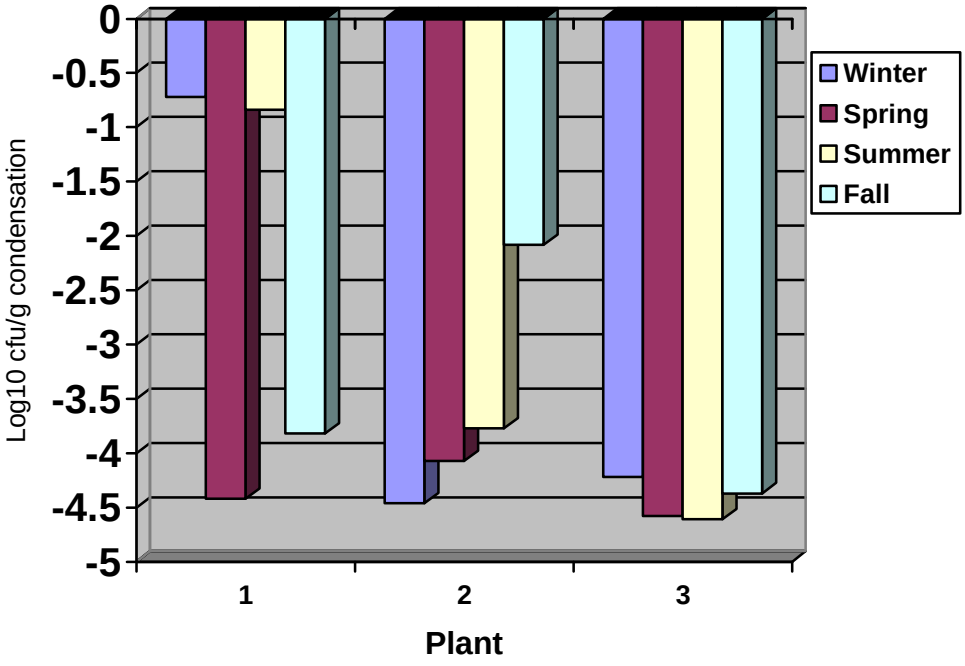


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Figure 5. Total Aerobic Plate Counts in Condensation Samples Collected in Fabrication Facilities During Operation

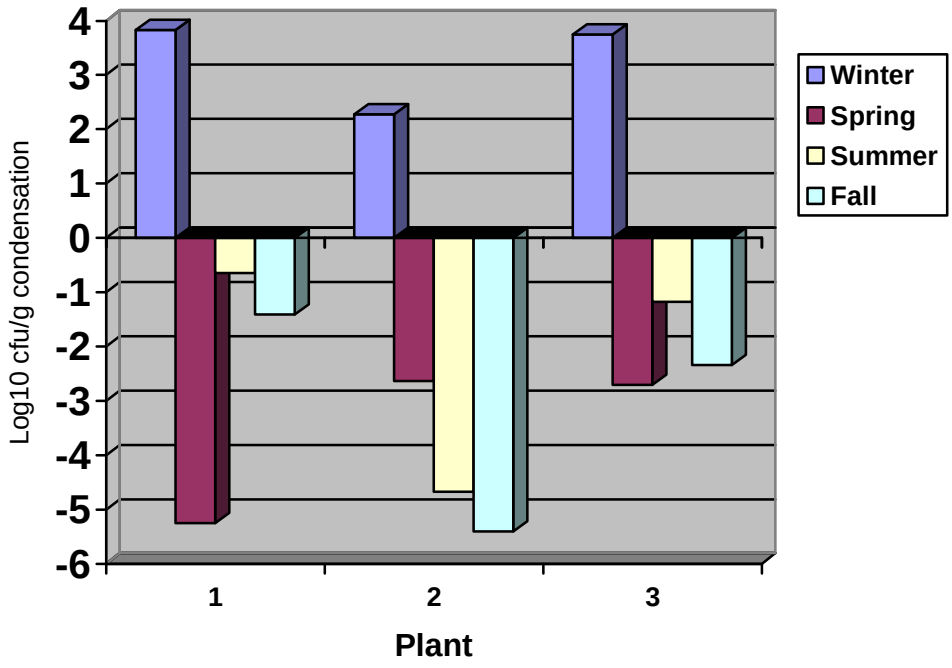
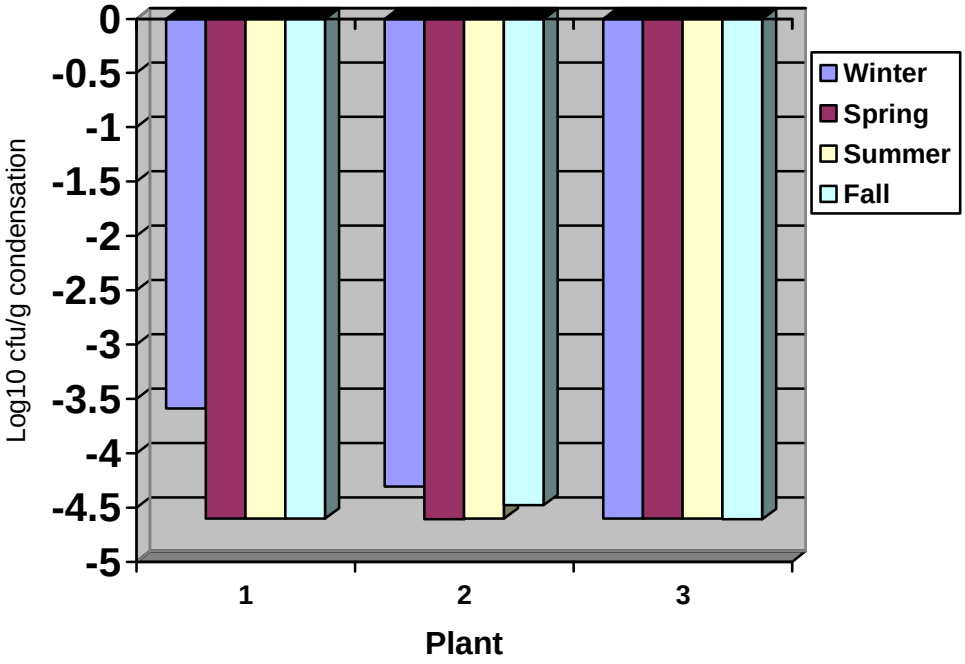


Figure 6. Total Coliform Counts in Condensation Samples Collected in Fabrication Facilities During Operation



In fabrication areas during operation, there appears to be a peak in all three processing plants in the amount of total aerobic organism collected during the winter with total numbers detected to be around 2.5-3.5 $\log_{10}$ cfu/ml of condensation (Figure 5). All other sampling times resulted in less than one cell detected/ml of condensation. Few coliforms were detected in the samples (Figure 6).

Figure 7. Total Aerobic Plate Counts in Condensation Samples Collected in Ready to Eat Processing Facilities Prior to Operation

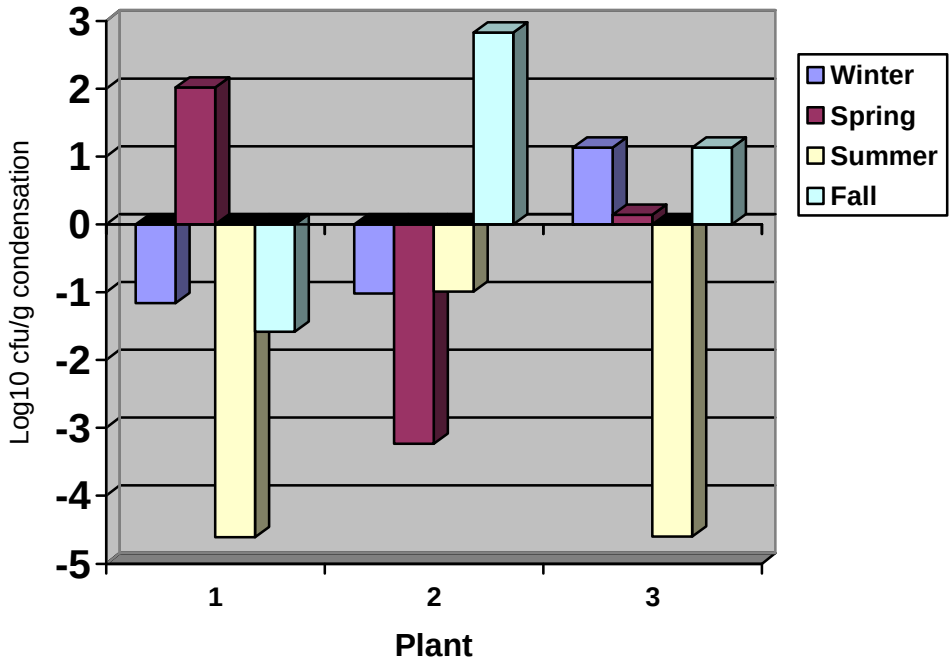
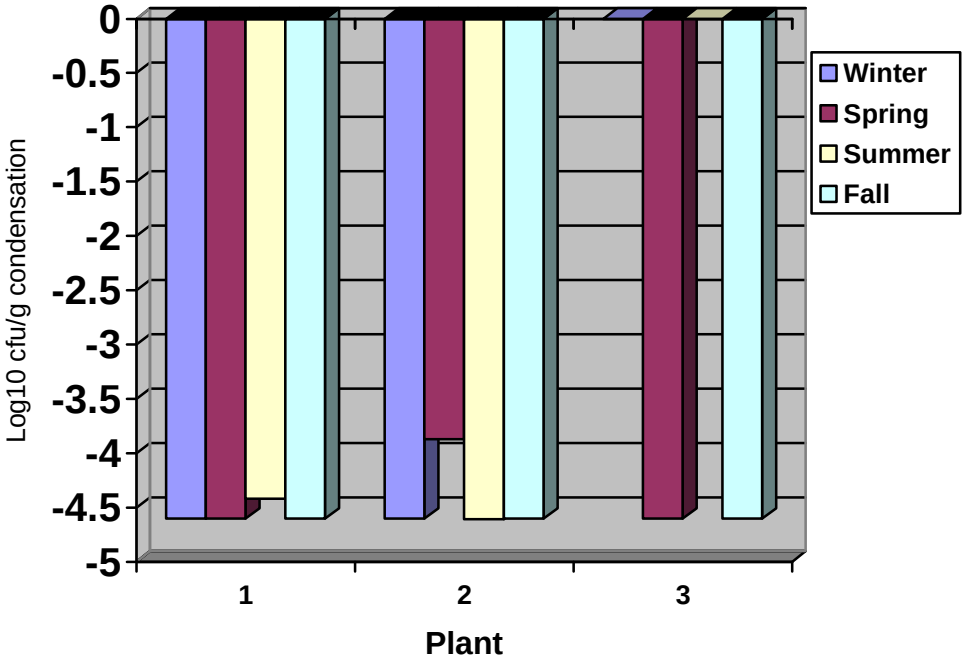


Figure 8. Total Coliform Counts in Condensation Samples Collected in Ready to Eat Meat Processing Facilities Prior to Operation



In pre-operational samples the total aerobic organisms detected was less then 2.5 $\log_{10}$ cfu/ml (Figure 7). All coliform counts were less than 1 cell detected per ml of condensation (Figure 8).

Figure 9. Total Aerobic Plate Counts in Condensation Samples Collected in Fabrication Facilities During Prior to Operation

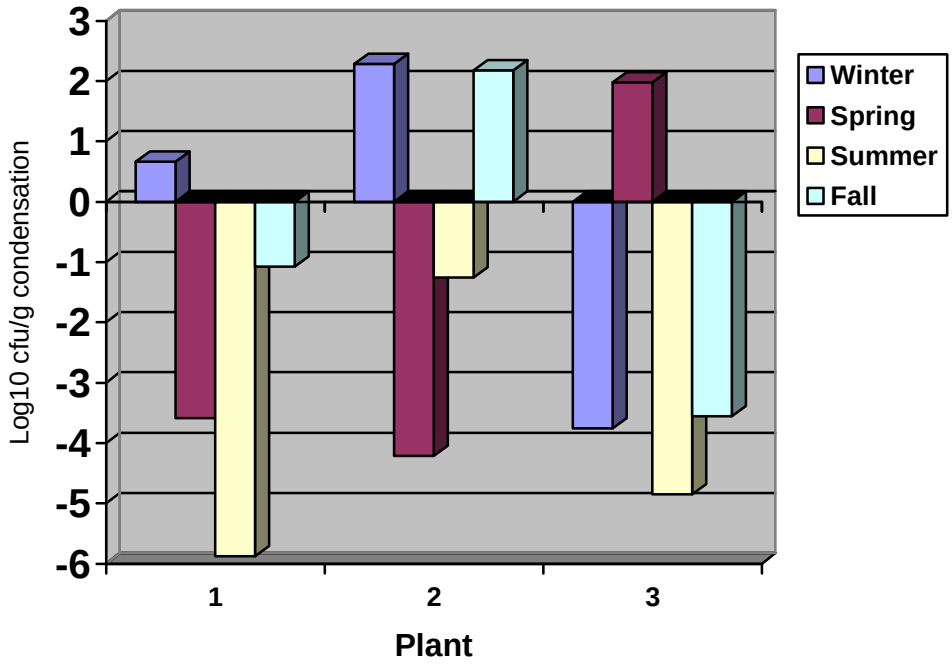
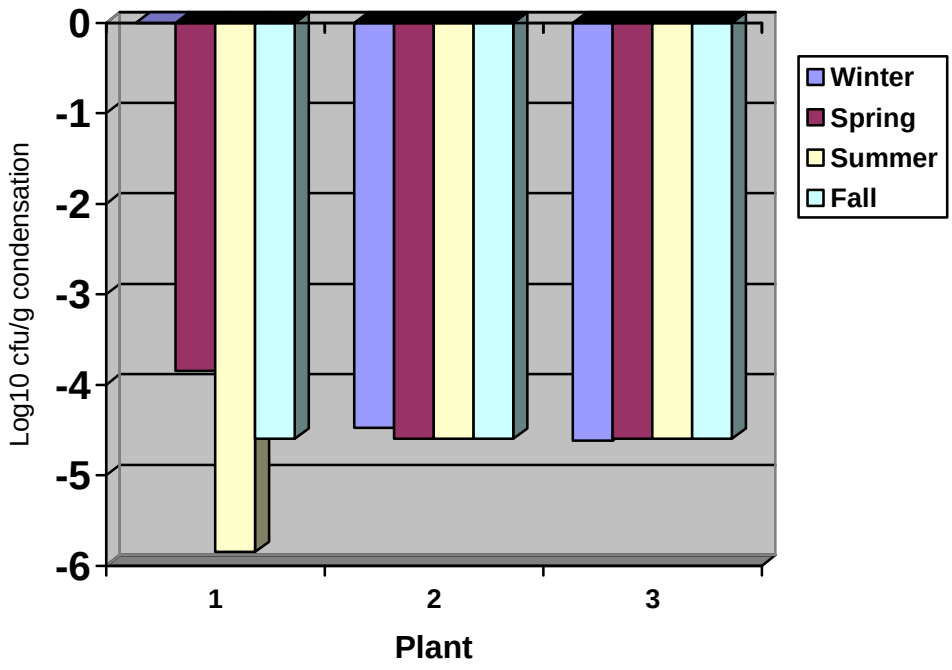


Figure 10. Total Coliform Counts in Condensation Samples Collected in Fabrication Facilities Prior to Operation



Following a trend similar to the observations made in the RTE areas, the total amount of aerobic bacteria collected in fabrication areas was less than 2.0 $\log_{10}$ cfu/ml of condensation (Figure 9). Few coliform bacteria were detected as well (Figure 10).

Figure 11. Total Aerobic Plate Counts in Condensation Samples Collected in Slaughter Facilities Prior to Operation

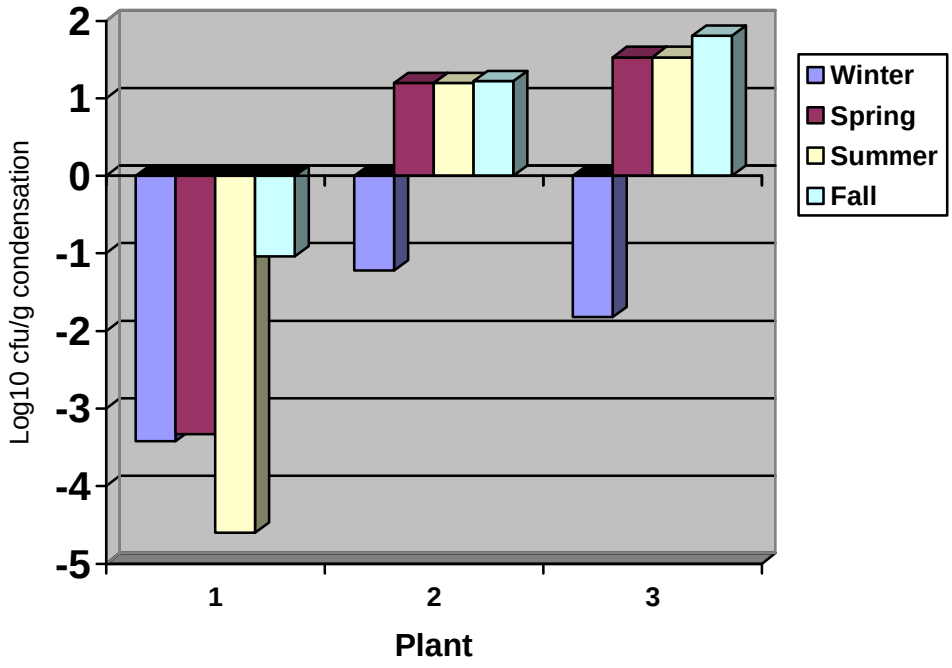
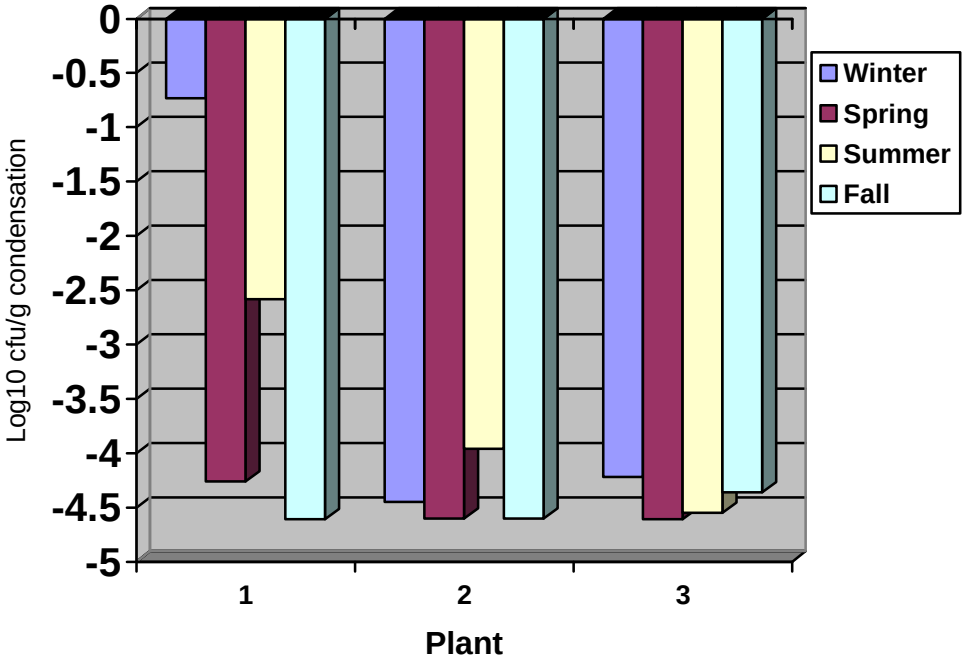


Figure 12. Total Coliform Counts in Condensation Samples Collected in Slaughter Facilities Prior to Operation



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Salmonella and Listeria spp

Of all the samples collected during both operation and pre-operation, only 2 samples were positive for the presence of Salmonella. These samples were collected from a beef slaughter area where there was high traffic. Only one sample in a ready-to-eat area tested positive for the presence of *Listeria* spp. This sample was collected on the raw side of the ready-to-eat area and not the cooked side.

Conclusions

This study was designed to determine the presence of microbial indicators present in condensation to determine if the presence of condensation in meat processing facilities pose additional risks when present during operation and before operation. In all facilities and all seasons, there was less than one coliform cell detected/ml of condensation in the plant. More than 50-100 ml of condensation had to be collected in order to detect measurable amount of bacteria. Similarly, there were few aerobic bacteria present in the samples. Samples were collected from environmental areas and from processing equipment and the presence of some aerobic bacteria is to be expected. The numbers were very low. There were no seasonality differences in the amount of condensation present in this study. Additionally. The amount of bacteria present was similar in

slaughter, fabrication and ready-to-eat areas in both pre-operational and operational samples. Additionally, the amount of bacteria detected was similar among all plants participating in this study indicating that data are likely applicable to a number of different operations.

Finally, the presence of only one positive *Salmonella* and one *Liseria* spp sample indicates that condensation likely poses a very low risk of product contamination when it comes into contact with the product. It is still important to control the presence of condensation in a plant as a part of good practices because is left uncontrolled it could be possible for the bacteria that are present to increase or to create a niche for a particular microorganism. However, condensation, present in slaughter, fabrication and ready to eat meat processing areas does not appear to contain microbial loads that will contaminate the product.

Figure 13. Total Yeast and Mold Counts in Condensation Samples Collected in Ready to Eat Processing Facilities During Operation

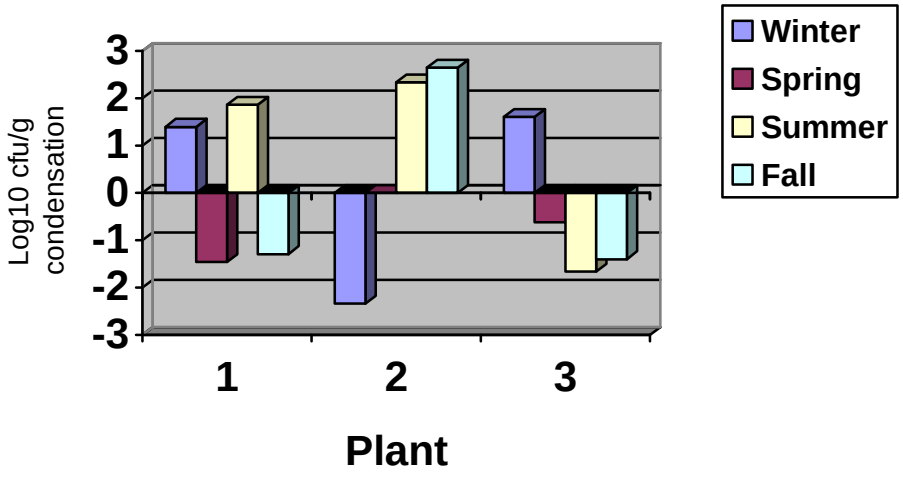

Figure 14. Total enterococcus Counts in Condensation Samples Collected in Ready to Eat Processing Facilities During Operation

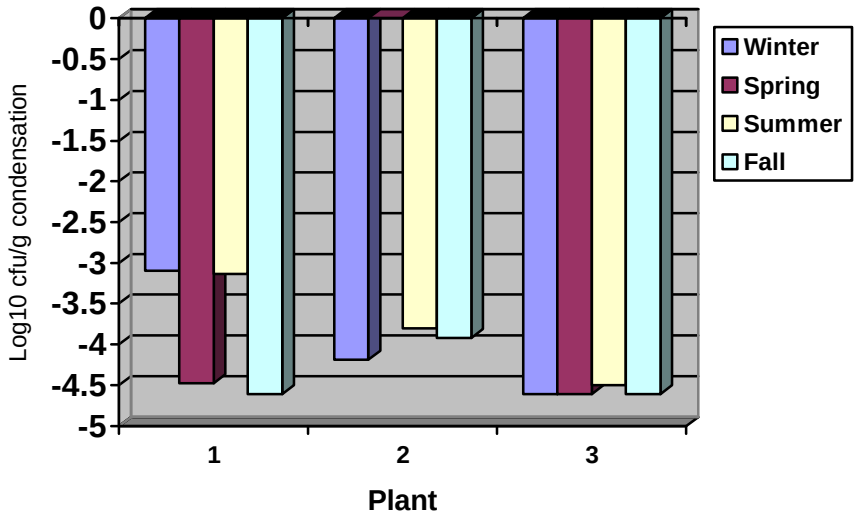

Figure 15. Total Yeast and Mold Counts in Condensation Samples Collected in Slaughter Facilities During Operation

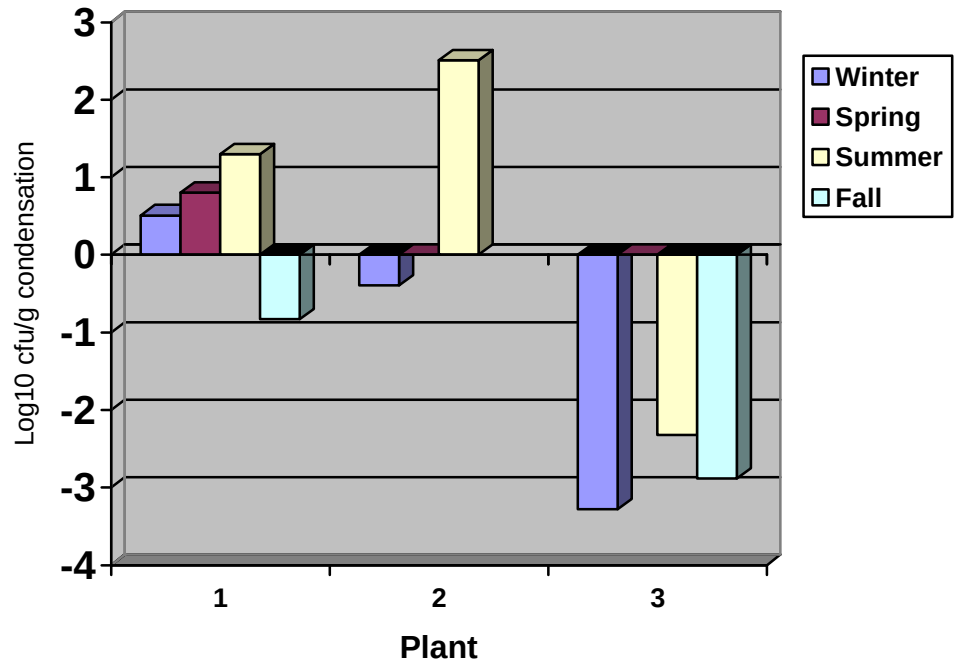

Figure 16. Total enterococcus Counts in Condensation Samples Collected in Slaughter Facilities During Operation

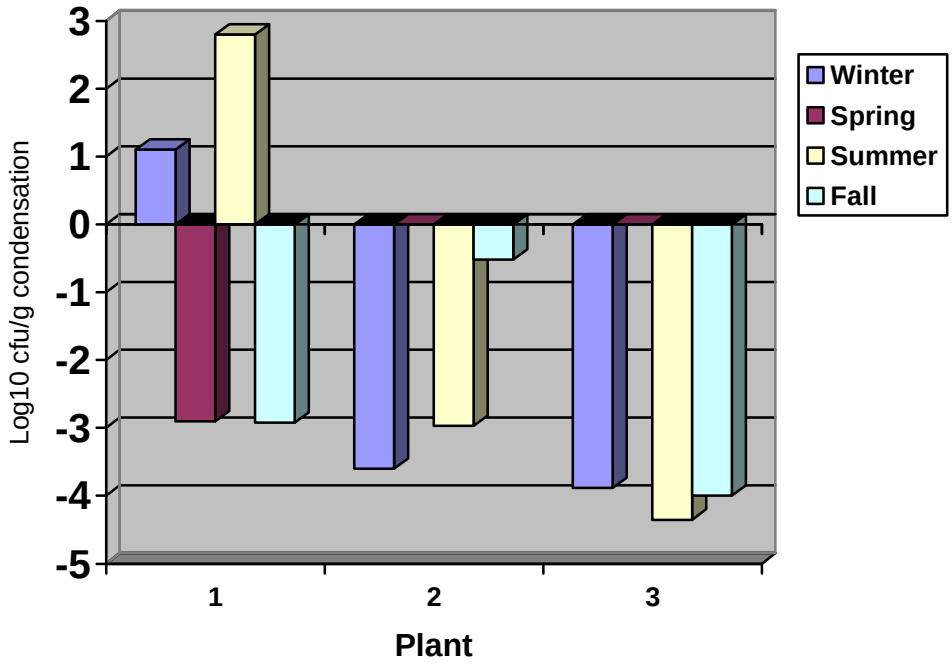

Figure 17. Total Yeast and Mold Counts in Condensation Samples Collected in Fabrication Facilities During Operation

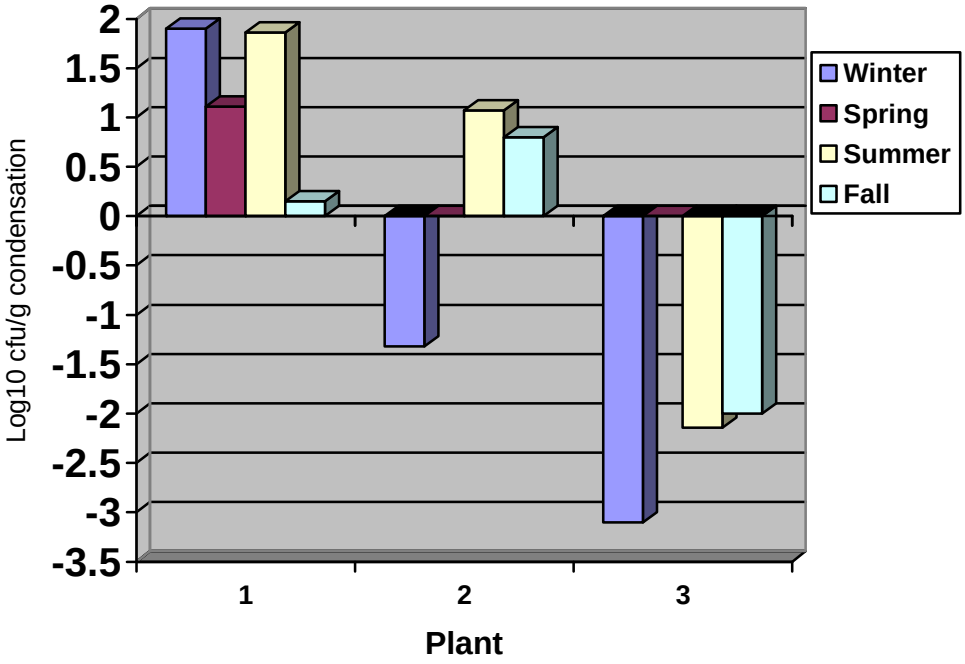

Figure 18. Total enterococcus Counts in Condensation Samples Collected in Fabrication Facilities During Operation

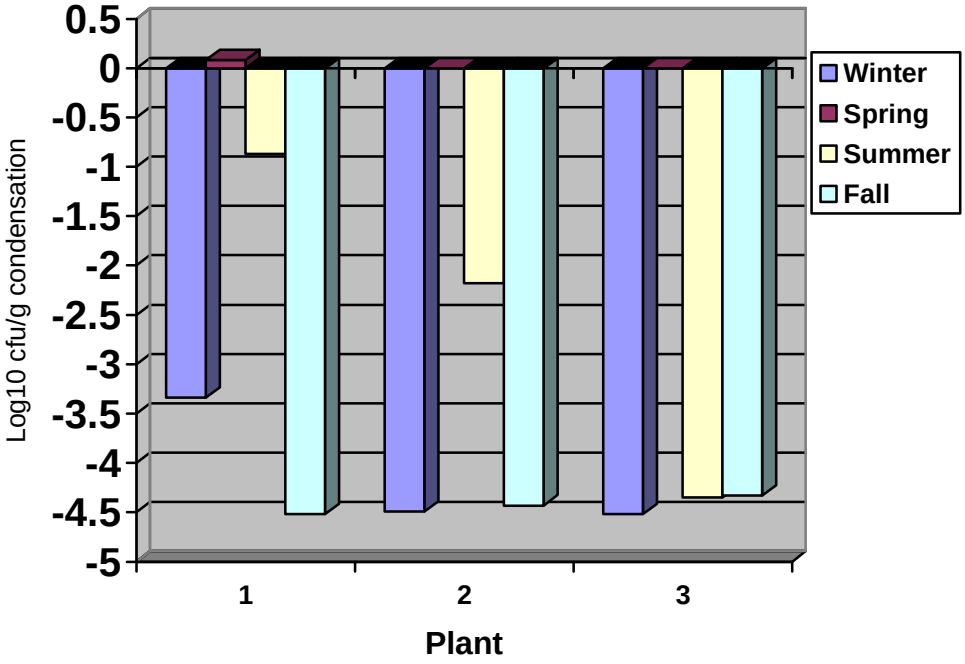

Figure 19. Total Yeast and Mold Counts in Condensation Samples Collected in Ready to Eat Processing Facilities Prior to Operation

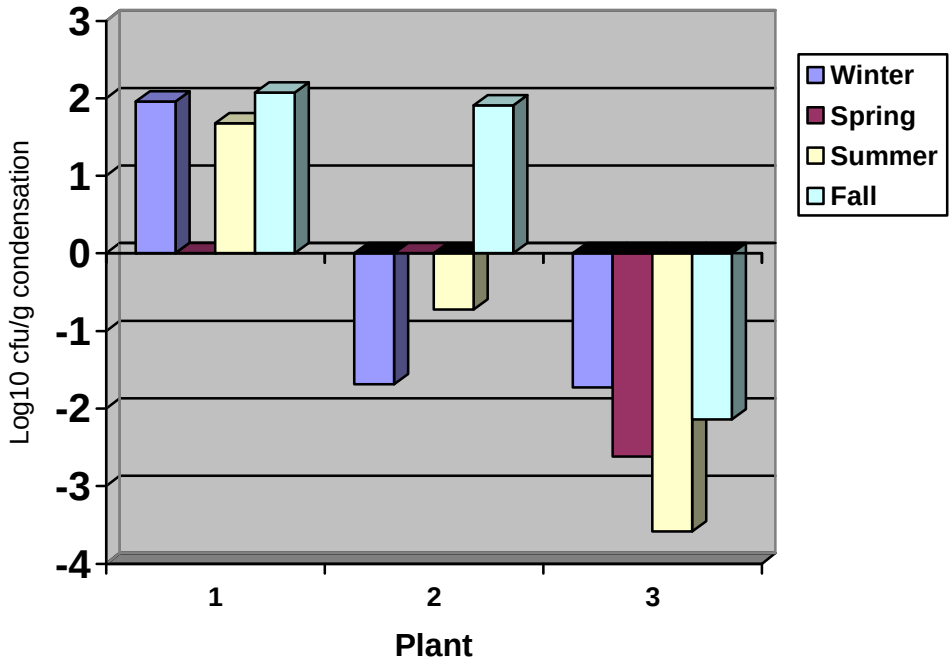

Figure 20. Total ENT Counts in Condensation Samples Collected in Ready to Eat Meat Processing Facilities Prior to Operation

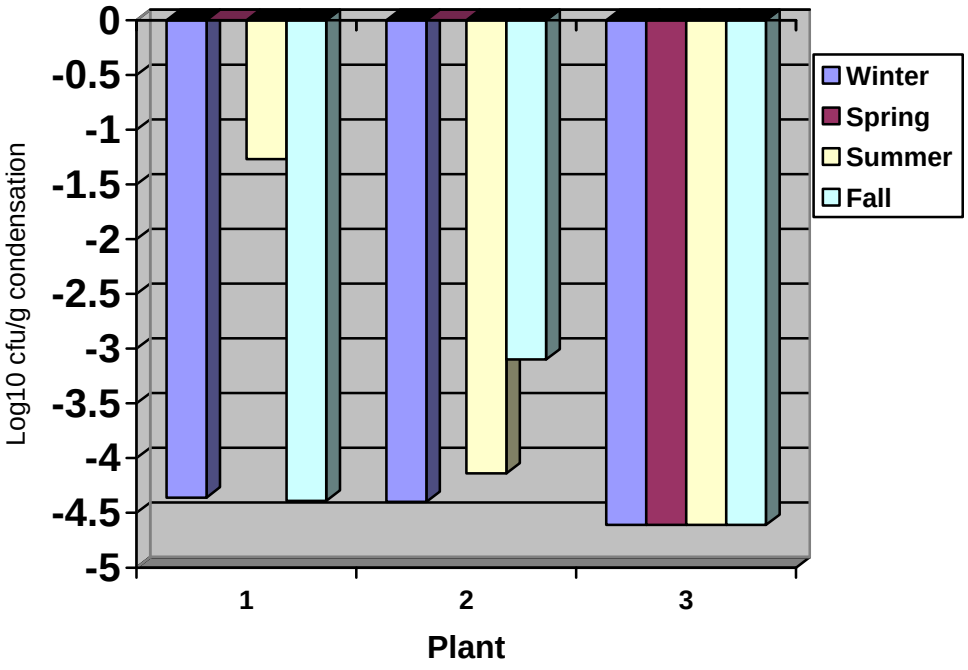

Figure 21. Total Yeast and Mold Counts in Condensation Samples Collected in Fabrication Facilities During Prior to Operation

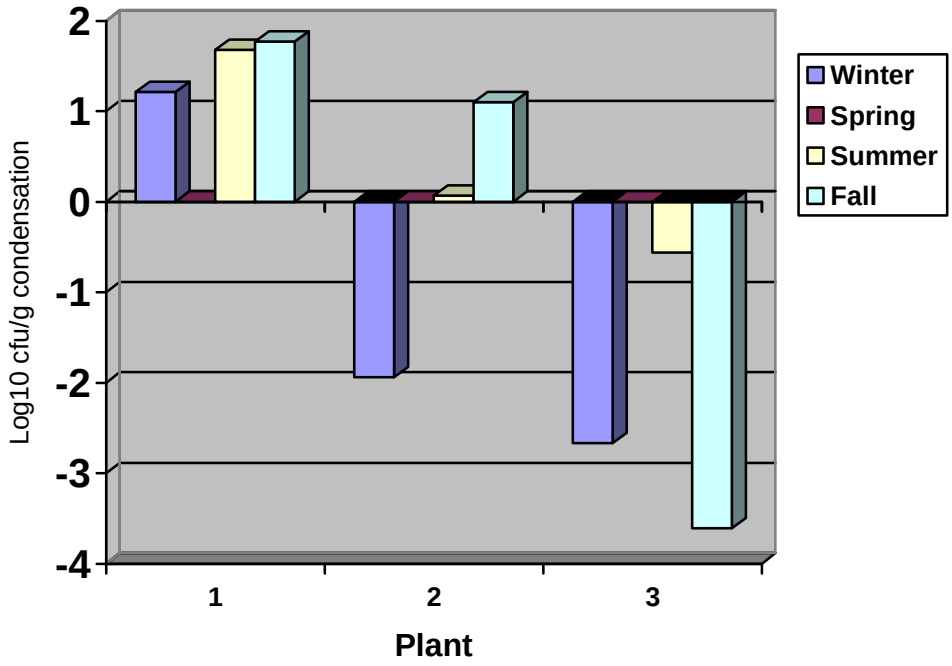

Figure 22. Total enterococcus Counts in Condensation Samples Collected in Fabrication Facilities Prior to Operation

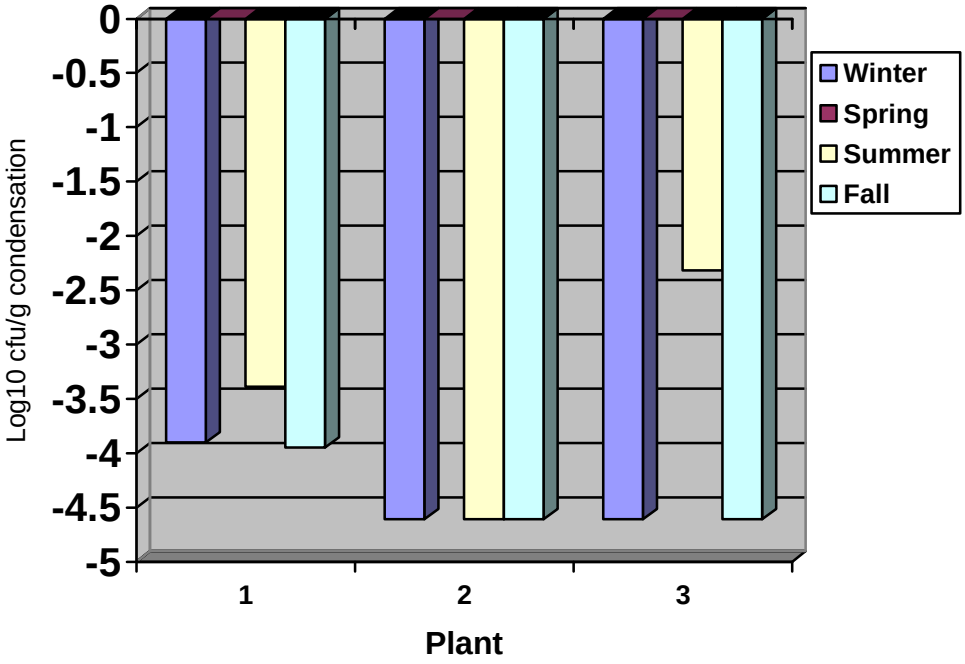

Figure 23. Total Yeast and Mold Counts in Condensation Samples Collected in Slaughter Facilities Prior to Operation

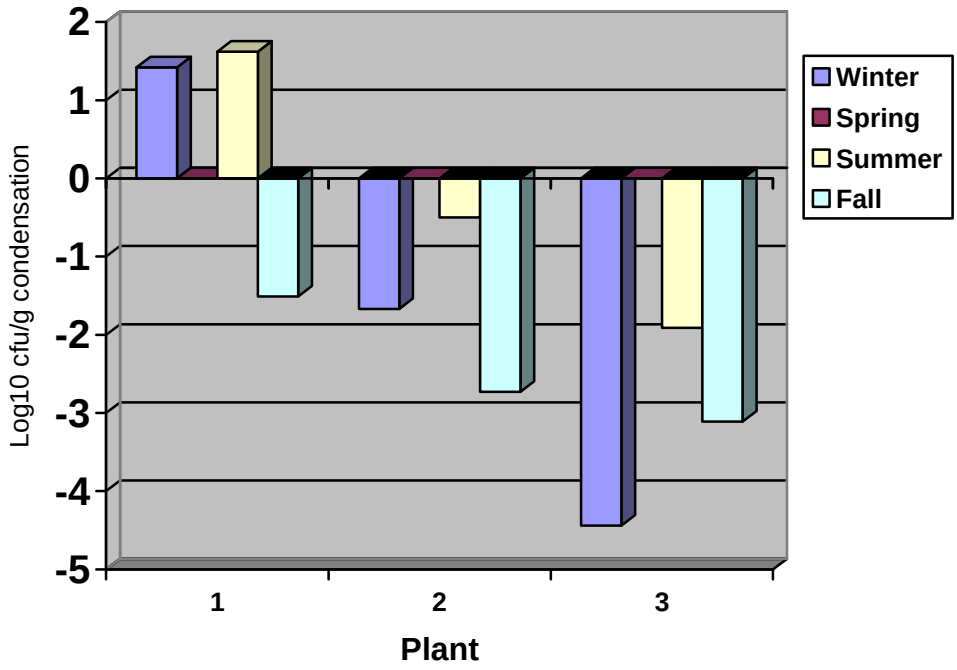

Figure 24. Total enterococcus Counts in Condensation Samples Collected in Slaughter Facilities Prior to Operation