final report

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Process Control Analysis for Red Meat Hygiene

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I. Abstract:

The Australian red meat industry collects microbiological data and collates them on an industry-wide basis. Statistical process control approaches are used to present the results of an individual establishment and those obtained across the whole industry against time. The methods of analysis and presentation of the summary data have been developed in consultation with industry. There is value in determining whether there are alternative approaches that may provide more value.

As the process hygiene index (PHI) is implemented across the industry, even more microbiological and hygiene data are being generated, and this too needs to be analysed to ensure that individual establishments and the industry as a whole gains the most value from these data. One item of particular interest to the industry is the occurrence of 'rare events' such as the detection of E. coli O157 in manufacturing beef, which is detected in approximately 0.1% of lots tested. When events occur rarely it becomes very difficult to determine when prevalence in an individual establishment or across the industry becomes unusually (significantly) high (i.e., events are clustered). Simple x-bar and S and CUSUMs charts were examined for temporal relations of collected data such as internal microbial data as well as carton meat assessment data, and coliforms data sets to confirmed positives for E. coli 0157 for several individual anonymous firms.

II. Executive summary

The Australian red meat industry collects microbiological data and collates them on an industry-wide basis. Statistical process control approaches are used to present the results of an individual establishment and those obtained across the whole industry against time. The methods of analysis and presentation of the summary data have been developed in consultation with industry.

As the process hygiene index (PHI) is implemented across the industry, even more microbiological and hygiene data are being generated, and this too needs to be analyzed to ensure that individual establishments and the industry as a whole gains the most value from these data. One item of particular interest to the industry is the occurrence of 'rare events' such as the detection of E. coli O157 in manufacturing beef, which is detected in approximately 0.1% of lots tested. When events occur rarely it becomes very difficult to determine when prevalence in an individual establishment or across the industry becomes unusually (significantly) high (i.e., events are clustered).

Simple x-bar and S and CUSUMs charts were examined for temporal relations of collected data such as internal microbial data as well as carton meat assessment data, and coliforms data sets to presumptive positives for E. coli 0157 for several individual anonymous firms. Weak temporal relationships of coliforms and presumptive E. coli 0157 positives were found. Future work includes matching other data that may or might be collected at individual establishments needs to be applied to these and other temporal data to determine if these help predict future E. coli 0157 events. If methods can be established to predict past E. coli 0157 events is determined this will help industry-wide to identify and possibly prevent future E. coli 0157 events.

III. Background

The Australian red meat industry collects microbiological data and collates them on an industry-wide basis. Statistical process control approaches are used to present the results of an individual establishment and those obtained across the whole industry against time. The methods of analysis and presentation of the summary data have been developed in consultation with industry.

As the process hygiene index (PHI) is implemented across the industry, even more microbiological and hygiene data are being generated, and this too needs to be analyzed to ensure that individual establishments and the industry as a whole gains the most value from these data. One item of particular interest to the industry is the occurrence of 'rare events' such as the detection of E. coli O157 in manufacturing beef, which is detected in approximately 0.1% of lots tested. When events occur rarely it becomes very difficult to determine when prevalence in an individual establishment or across the industry becomes unusually (significantly) high (i.e., events are clustered).

IV. Project objectives

1.Advice on alternate methods of analysis for routine microbiological data collected from red meat processing establishments
2.Suggest an approach to the detection of clusters of otherwise rare events

V. Methodology

Meat & Livestock Australia (with Andreas Kiermeier, PhD, PIRSA-SARDI, as MLA representative) and Darrell W. Donahue, PhD, University of Maine (US) examined anonymous data sets of Product Hygiene Assessment (PHI) for temporal relationships of carton meat assessment and coliforms counts to presumptive E. coli 0157 findings. Simple x-bar and S and CUSUMs charts were examined for the basic temporal analysis.

VI. Results

As established In the PHI data, weak trends and relationships were found between the carton meat assessment and coliforms microbial data to the presumptive E. coli 0157 found in a given establishment using the x-bar and S charting. One such graph can be seen in Appendix A at the Preliminary CUSUM charts were developed for further analysis of these relationships. Due to both data and time restrictions these analyses were only performed on two anonymous establishments.

(Note: These results are preliminary and were developed during a 2.5 day meeting in Sydney, Australia, during 10-12 July 2012)

VII. Discussion / Conclusion

During these process control analyses, it was determined that there might be other data that are collected which are part of internal establishment data bases, both quantitative (e.g., other internal microbial data collected) and qualitative (e.g., QA/QC observational process data) that might be useful to investigate further. These additional data may be useful to determine other relationships.

The next steps for this analysis were determined as follows. We need to collect more data from more establishments, particularly those who have had a high frequency of presumptive and/or confirmed positives. Other data sources for applicable establishments should include:
1. PHI data from more establishments for temporal analysis; (e.g., coliform and carcass data sets from the ESAM reports).
2. PVC and coliform data for cartoned products and see how the presumptive positives temporally relate the production of lots where the presumptives were found.
3. TVC and coliforms data for carcasses and relate temporally to production data.
4. Examine other types of PHI data against production and presumptive for any relationships.
5. Examine the sampling plan for ESAM data; are the spots used in sampling representative of the carcass?
6. Review qualitative types of data that may be collected by QA/QC personnel (or line supervisors); are data being recorded that is not part of the required reporting that may be germane to the prediction modeling for E. coli 0157 likelihood. (Parallel question: Can we trust the observations of these personnel more than their analysis?) (see Pable et al. 2010).

In addition, combining several of the types of data listed here in to develop and analyze multivariate process control charts (see Montgomery 2009, chapter 11; Kourti, 2006; Raatikainen et al. 2005; and Tokatli et al. 2005) should be examined as a possibility for analysis.

A further more involved technique for monitoring rare event type data is required.

VIII. Relevant appendices

Appendix A. Example graph relating coliform data and presumptive E. coli 0157 positives for one establishment.

Appendix B. Appendices supplied by the AOAC as part of this analysis. These appendices, which are a work product from an AOAC working committee are labeled Appendix F and Appendix F.1 as properly numbered as part of the AOAC work product under contract.

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Appendix A. Example graph relating coliform data and presumptive E. coli 0157 positives for one establishment.