final report

Project code: P.PIP.0478

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Date published: 18 August 2015

PUBLISHED BY
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Process control of sheep processing and possible effects on product shelf-life

This is an MLA Donor Company funded project.

Meat & Livestock Australia acknowledges the matching funds provided by the Australian Government and contributions from the Australian Meat Processor Corporation to support the research and development detailed in this publication.

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Executive Summary

A processor was interested in investigating their various aspects of process control with respect to slaughter, dressing, boning and packaging operations. The specific objectives of this project was to:

1. Assess production and cold chain management for effect on process control and shelf-life.
2. Assess process control monitoring and shelf-life testing programs.
3. Assess existing data on product and supply chains (microbial, temperature, etc) for suitability to predict shelf life ranges using University of Tasmania (UTas) models.
4. Design a study to assess the effect of multiple variables on the shelf-life of chilled vacuum-packed primals.

A meeting was arranged with the processor and this document is a record of that meeting. As part of the meeting the slaughter floor and boning room were visited and presentations were made on our red meat shelf-life and our carcase microbial profile. As well, shelf-life studies, chilled products, destinations and transport logistics were discussed. Subsequently, options for extending shelf-life were presented and potential future investigations were developed and explored.

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1 Background

In mid April 2015, a processor company expressed an interest to Meat & Livestock Australia (MLA) about looking at ways to improve process hygiene within their supply chain, with the primary objective of extending shelf-life of chilled products.

It was thought that investigations to assess ways of improving shelf-life might emerge by bringing both parties together and that these investigations could be funded via a Plant Initiated Project (PIP). A meeting was arranged and this document is a record of that meeting.

The significance for industry in general and for the processor in particular is that some markets demand arbitrary shelf lives which are difficult to achieve under some circumstances e.g. a missed scheduled transhipment.

Shelf-life extension is therefore an overarching aim for establishments which service distant markets with chilled products.

2 Projective Objectives

The processor was interested in nvestigating various aspects of process control in slaughter, dressing, boning and packaging operations.

The intention of the project was is to investigate and evaluate the effectiveness of current techniques, microbial and sensory characteristics of lamb products, with the view to look at quality and shelf life. Investigation was needed to answer numerous questions throughout the supply chain. The immediate requirement was for advice on process control, and statistical analysis.

The specific objectives of this project were to:

1. Assess production and cold chain management for effect on process control and shelf-life
2. Assess process control monitoring and shelf-life testing programs
3. Assess existing data on product and supply chains (microbial, temperature, etc) for suitability to predict shelf life ranges using University of Tasmania models
4. Design a study to assess the effect of multiple variables on the shelf-life of chilled vacuum-packed primals

3 Methodology

Information was collated prior to the meeting to provide information on the processors microbiological profile, based on shelf-life studies done in 2010, and on PHI information submitted by the processors to Department of Agriculture (DA). We are grateful to Jessica Tan from the South Australian Research and Development Institute (SARDI) for presenting this information.

The processor staff also presented facts and figures, plus processing information prior to the meeting.

The meeting proceeded according to an agenda with a staged approach (Table 1).

Table 1: Agenda for the MLA meeting

Stage 1 Processing – Slaughter Floor and boning room
Stage 2 Introductions – who are we? Purpose – what do we hope to get out of the meeting? Shelf-life – Powerpoint presentation to get us on the same page Micro profile – Powerpoint presentation
Stage 3 Shelf-life studies –data from our studies Markets – chilled product and destinations
Stage 4 Shelf-life – options for extending
Stage 5 Investigations – what do we need to investigate?
Stage 6 Formalise options for investigations

4 Results

4.1 Stage 1 outcomes

All participants inspected the slaughter floor and boning rooms, which provided background for discussions later on processing control and export particularly on chilled products.

It was noted that a much higher proportion of sheep was processed compared with lambs, with the former being boned and frozen while the latter are boned, vacuum packed and chilled.

4.2 Stage 2 outcomes

Introductions indicated a mix of processing, sales and marketing and laboratory expertise from the processor staff and statistical analysis, process control and food safety from MLA.

The purpose of the meeting was formalised with the emphasis on process control leading to longer shelf-life; a long-term aim of 120 days shelf-life through the marketing chain was stated.

A Powerpoint presentation was provided on the aspects of shelf-life, which was based on the MLA industry guideline “Shelf-life of Australian red meat” (MLA, 2014), was a useful baseline for all participants.

A Powerpoint presentation on aspects of the microbiology of the companys’ products was a useful start for discussion on process control.

Profiles for Total Viable Counts (TVC) and *Escherichia coli (E. coli*) prevalence were prepared by SARDI and summarised trends between the period of 2007 to April 2015 were provided to the company.

Data were also presented from shelf-life trials done by the companies lab staff during 2010. It was seen that high counts were not obtained and were closely related to storage temperatures in the trials.

4.3 Stage 3 outcomes

4.3.1 Shelf-life studies

Prior to the meeting the company offered to make available data on shelf-life testing to University of Tasmania (UTas) researchers to assist in improving a shelf-life predictor tool currently under development.

As part of the analysis of the company's laboratory data it was identified that opportunities existed for improving laboratory records.

4.3.2 Markets – chilled product and destinations

A comprehensive review was given by the company's marketing staff of how our products proceed to various global markets.

Some chilled products are air freighted while others are sea-freighted. Detailed information was provided on normal journeys and on the occasional journey where there are problems e.g. a container misses its transhipment flight or vessel. The effect can be extreme because of the tight limits imposed by some countries on shelf-life remaining at the time of landing.

The hope was reiterated that shelf-life could be improved to 120 days, which would provide more certainty when customers demand very long shelf lives.

The company reviewed the current version of the UTas predictive microbiology tool and commented on how its development might proceed.

The company also identified ways in which to retrieve data logger outputs from our customers.

4.4 Stage 4 outcomes: Shelf-life – options for extending

Participants in the PIP considered ways in which shelf-life might be extended by using a framework from live animal to packing final products.

In Table 2 are the areas presented for further consideration as possible investigations that could be undertaken. After careful consideration some topics were selected for further discussion.

Table 2: Investigations which may produce opportunities for extending shelf-life

Process Control Process control on the slaughter floor • Assess process control • Identify high contamination sites before washing, after washing, after chilling • Identify which operations contribute and to what extent? Process control in the boning room • Assess hygiene of food contact surfaces • Assess microbial profile of final products
Interventions Interventions on the slaughter floor • Hot water (difficult – needs a cabinet) • Lactic Acid Interventions during chilling • Spray chilling with chlorine dioxide Interventions in the boning room • Lactic acid on carcases (pre-trim) • Sanitising belts (peroxyacetic acid) • Pre-pack intervention, e.g. spray immediately before packaging • Evaluate effect of decontamination treatment on shelf-life
Packaging Changes • Modified Atmosphere Packaging (gas flushing) • Active packaging (antimicrobial films)

4.5 Stage 5 outcomes: Investigations – what do we need to investigate?

We worked on the selected investigations from Table 2, putting some detail on how treatments, sampling rates, bacteria to be enumerated, plus indicative costs if samples were sent to an outside laboratory.

A number of investigations were discussed, with the following outline for each.

4.5.1 Investigation 1: Evaluation of process hygiene

Aim: Identify high contamination carcase sites and the effect of final wash and chilling

- Sample up to six carcase sites on the carcase – locations to be decided
- Each site 10×10 cm^2, sampled separately
- 25 carcases, one per day, at each carcase site over 25 days
- Locations: before final wash, after final wash, after chilling
- Total 450 samples for TVC (35°C), *E. coli*, and Enterobacteriaceae
- Cost for outside lab: approx. $50 per test, i.e. 450×50 = $22,500

4.5.2 Investigation 2: Environmental study of food contact surfaces in the boning room

Aim: Identify high contamination sites in the boning room

- Sample 10 sites in the boning room – belts, tables, band saws, etc
- Swab each surface up to 1m^2 with Whirlpak sponge
- Swabbed on one day, every 2 hours throughout the shift (i.e. 5 times)
- Total 50 samples for TVC (35°C)

- Cost for outside lab: approx. $30 per test, i.e. 50×30 = $1,500

4.5.3 Investigation 3: Survey of microbial profile of final products

Aim: Assess the microbial profile of final products

- For each final product, collect 5 samples per day (collected throughout the shift) over 5 days
- Product in bag or swab surface 10×10cm^2 with Whirlpak sponge (depending on product, TBA)
- Enumerate for TVC (25°C for 4 days), *E. coli* and Enterobacteriaceae
- Cost for outside lab: approx. $50 per test, i.e. 50×25 = $1,250 per product

4.5.4 Investigation 4: Decontamination of final products

Aim: Assess the efficacy of decontamination treatments on final products

- Ultimate aim is to decontaminate final products using an inline decontamination spray.
    - Peroxyacetic acid at 200ppm is in common use in North America (Youssef et al., 2014)
    - Acidified sodium chlorite (ASC) approved by Food Standards Australia New Zealand (FSANZ) as a processing aid (e.g. Midgley and Small, 2006)
- Experimental validation initially needs manual spray (allows evaluation of numerous decontamination treatments)
- Use legs as a worst case, suspend on a hook to allow full coverage, observing minimum contact time
- Concentrations: 0 (control), 100, 200 and 500ppm of peroxyacetic acid and up to 1000ppm for ASC
- Repeated on each concentration on five final products each day, for five days (25 samples per concentration)
- Sponge whole product surface using Whirlpak sponge
- Enumerate TVC (at 25°C for 4 days)
- Cost for outside lab: approx. $30 per test, i.e. 30×100 = $3,000 per chemical

4.5.5 Investigation 5: Shelf-life of decontaminated final products

Aim: Assess the effect of decontamination treatment on shelf-life

- Select the most effective decontamination chemical and concentration from Investigation 4.
- Select 60 final products – treat 30 of these, the remainder are used as controls (untreated)
- Pack all products as normal and store them at -1°C for the period of the trial
- Using five replicates at each time, sample at days 0, 60, 80, 100,120, 140
- Enumerate TVC (at 25°C for 4 days)
- Cost for outside lab: approx. $30 per test, i.e. 30×60 = $1,800

5 Discussion

5.1 Assess production and cold chain management for effect on process control and shelf-life

- Microbial benchmarking of carcase sites, other than those used for ESAM swabbing, needs to be undertaken to gain better understanding of processing hygiene and identify areas that may affect shelf-life.
- Temperature logs should be obtained and assessed routinely, especially in conjunction with microbiological testing undertaken at port-of-entry or by customers.

5.2 Assess process control monitoring and shelf-life testing programs

- Monitoring of process control through ESAM reports sent from SARDI or via in-house monitoring systems appears limited, given presence of substantial fluctuations in microbial levels over time without identifiable cause.
- Shelf-life testing programs need to, and will be, modified to allow enumeration of psychrotrophic bacteria.

5.3 Assess existing data on product and supply chains (microbial, temperature, etc) for suitability to predict shelf live ranges using University of Tasmania models

- Existing microbial shelf-life data not suitable for UTas models
- Temperature logger data from extended supply chains would be useful, especially, if microbial results at the end of shipping could be obtained.

5.4 Design a study to assess the effect of multiple variables on the shelf-life of chilled vacuum-packed primals

- Several investigations have been proposed
- We are interested in a final product decontamination treatment
- We are interested in benchmarking carcase, product and boning room contact surface hygiene. This will enable identification of most contaminated carcase sites and hence allow us to improve relevant dressing processes and end product microbial levels and shelf-life.

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