final report

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Prepared by: Meat & Wool New Zealand

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Milestone

Ongoing data collection / collation in up to 6 existing Smart Stim prototype plants

Abstract

Summary: Three installations have used the Smart Stimulation system (SS) specifically to manage the post mortem pH decline in order to improve consistency of processing. These installations are at the Australian Country Choice (ACC; beef), Auckland Meat Processors (AMP; sheep), and Riverlands Eltham (hot-boning beef).

All three systems have been calibrated and undergone some level of validation, and these have demonstrated that the SS system operates successfully. The process has allowed the software to be modified and tested to meet the different processing conditions: for example, the AMP sheep installation operates at 8 carcases/minute using an 8 segment rubbing electrode; the ACC beef operates at approximately 2 carcases/minute using a 2 segment rubbing bar; and Riverlands Eltham operates at approximately 1 carcass/minute and, because the chain is not continuous, uses a single, pneumatically operated electrode and stimulates a static carcass. In each case, the software and hardware has proved flexible enough to accommodate the different processing arrangements

Project objectives

1) Collect and collate data from existing prototype plants covering existing beef and sheep processing scenarios
2) Import Smart Stimulation data into the QOP Simulator.
Evaluate algorithms for prediction of other eating quality traits including Ultimate pH and tenderness where possible

Success in achieving milestone

The progress of the Smart Stimulation system at each of the host Companies is discussed.

The Smart Stimulation system is working effectively at each of the plants. Taken collectively, the various systems are successfully controlling the rate of pH decline to the user defined target pH values and all the plants are now using the stimulation systems as part of their usual commercial operation. The ability of the system to predict ultimate pH is reasonable, but further work is required to improve the accuracy of the prediction.

Each of the installations are discussed individually below.

1. **pH control**

Australian Country Choice (ACC) - Beef.

This installation is primarily focussed on controlling the pH decline to meet the MSA grading standard. Accordingly, the calibration was setup as a target pH at 2 hours after stimulation, at which point the carcass temperature is typically between 25 and 30°C.

Stimulation responses and subsequent pH declines were measured from a total of 226 carcasses. The amount of stimulation was varied between 5 and 20 seconds to

produce a range of pH declines, from which a calibration was derived. The coefficients were then entered and the system setup to test the carcass pH at 5 second intervals. Once the predicted target pH is attained, the stimulation is stopped. Once the calibration was completed, two different target pH values were used to validate the system.

Figure 1: 2 hour pH predictions**.**

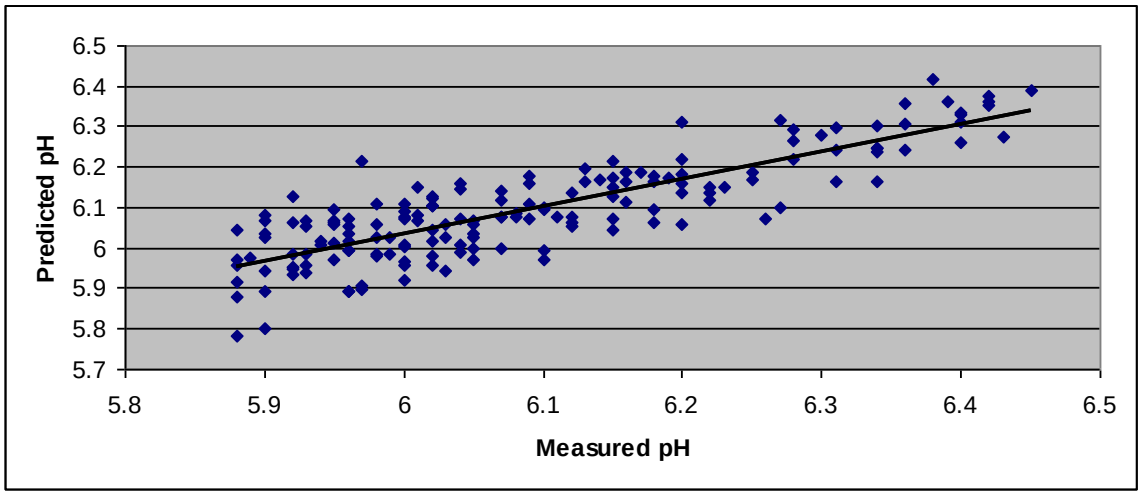

Table 1: Validation of SS system

Target pH	**6.2**	**5.85**
n	66	74
Average carcass pH	6.13	5.87
No of test cycles	**% carcasses**	**% carcasses**
1	73	41
2	18	16
3	6	13.5
4	3	13.5
5	0	8
6	0	8
Off-target carcasses (<1.5 pH unit deviation)	**% carcasses**	**% carcasses**
pH too high	3	6.8
pH too low	4.5	4

The proportion of off-target carcasses does not include carcasses that received a single test pulse (the minimum necessary to establish the pH status) but still produced a pH below the target value. This represents carcasses whose pH decline is already too rapid and therefore cannot be controlled by the SS system.
The incidence of carcasses that reached a pH more than 1.5 units less than the target after a single test pulse was 8 (12%) on trial 1 (target pH 6.2) and 5 (7%) on trial 2.

The extent to which the stimulation required to produce the initial pH test is responsible for the low pH carcasses was not determined. To do this, the pH declines of unstimulated carcasses would need to be measured. At this stage, there is at least a possibility that the 5 seconds of stimulation required to derive the initial pH measurement may in itself be sufficient to push some carcasses past the target pH.

Remote access to the Smart Stimulation computer and software has now been set up (as part of programme P. Pship 0341 (milestone 3) and was used routinely during the course of the most recent trials at ACC. This allowed CT staff on site to work closely with the CT NZ office. This remote access system enables CT to monitor the load cell responses, upload data files, make adjustments to the software and change the user defined inputs as required.

General observations:

1. The present setup of the hardware requires some modification to the second rail to ensure that the carcasses leave the second rail without current flow through the carcass, as this can cause the carcass to bounce and pose a potential problem to operators at the first workstation. This problem is being addressed by ACC.
2. Half carcasses on sequential hooks can, if their forelegs are pointing towards each other, touch and physically interfere with each other. If this occurs during the testing process, some distortion of the pH prediction can occur.
3. Carcasses will occasionally fail to be turned to present the muscle side of the carcass to the electrode. Under these circumstances, the carcass curls away from the electrode during stimulation and will often break contact and bounce. The pH measurements, and the effectiveness of the stimulation, are compromised under these conditions.
4. The risk that the first pH test is sufficient to cause an excessive pH decline should be confirmed.

TRIAL SITE 1 - sheep.

The kill at AMP has increased dramatically since the installation of the Smart Stimulation system increasing from between 5 to 6 per min to the current 8 to 9 per min. The set up consists of an 8-segment stimulation rail; there are 4 load cell segments each separated by independently controlled stimulation rails. One provides the test pulses to the load cell rails while the other provides a continuous 15 Hz stimulation waveform. Each rail is independently controlled through relays in the control system.

The objective of this installation was to provide an easily accessible commercial unit for all development activities. However, in addition to this, the requirement from AMP/Wilson Hellaby is to use the system to control pH decline. Since the installation of the system, the kill at the plant has changed from being largely local market to having a large chilled export market. In addition, the introduction of an IBEX chiller has expanded the range of chilling options for their lamb and mutton kill and, recently, this has extended to include a warm boning operation. This increase in the range of operations and markets has now placed a greater emphasis on the requirement of pH control and the ability to stimulate to different pH targets – this has therefore been the recent focus of the work on this installation.

Overall, the system is doing an effective job at controlling the pH decline as shown below. Typically, the system is running with the target pH at 6.2 which is a reasonable level for the current processes and markets.

The system is now running continuously with regular monitoring and checks of the calibration being performed at least weekly by CT.

Earlier on in the year, for reasons that were unclear, bouncing of carcasses over the first 2 load cells increased in frequency and distorted the load-cell responses. This was largely solved by the installation of 'whisker arms', a spring loaded flexible steel arm that made contact with the carcass on the first stimulation segment prior to load-cell one. This maintained electrification of the carcass in circumstances where the initial carcass contraction caused a loss of contact with the main stimulation electrode and prevented continuous bouncing of the carcass.

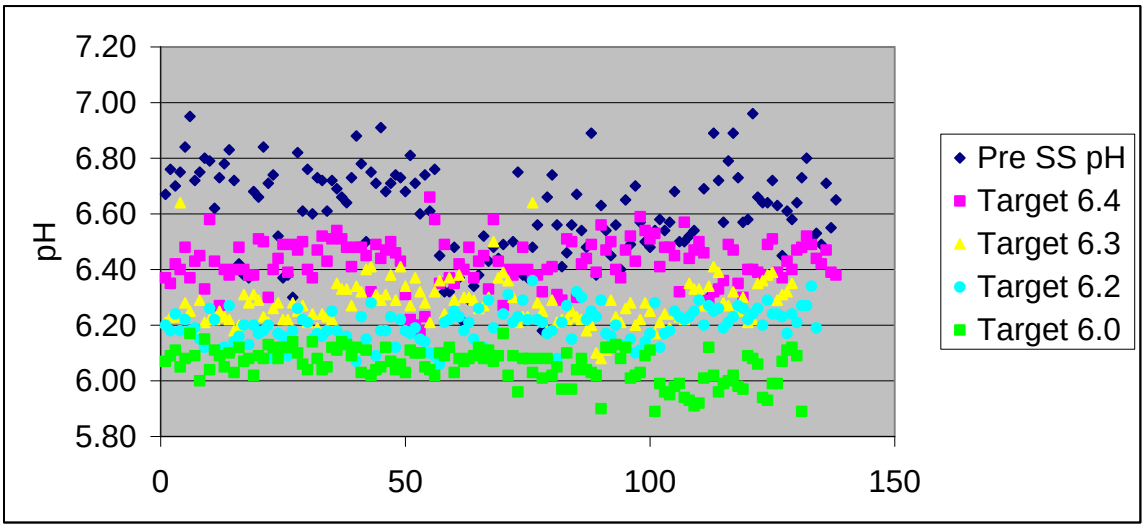

Figure 2. Target pH results

TRIAL SITE 2 - Beef

The installation was originally intended as an ultimate pH prediction system, a particularly important application for hot boning plants (see below). However, as part of an on-going product auditing process, it recently became apparent that the control of pH decline was inadequate when the stimulation was based on a constant stimulation duration: purge in the product increased and this was attributed to an accelerated pH decline that could not be linked to any changes in the electrical inputs and is assumed to be an animal effect.

The other key distinction of the installation is that the stimulation is delivered before full dressing of the carcass: the stimulation is applied to the whole carcass immediately after hide removal and prior to evisceration. The implication of this difference, relative to other installations based on stimulating the split carcass, is part of the investigation.

The pH data collection for the validation of this installation was carried out in collaboration with the plant personnel.

The carcass pH was evaluated at 5 second intervals for each carcass up to maximum stimulation periods of 30 seconds.

As with the other installations, the SS prediction of carcass pH has a robust relationship to the measured pH (Figure 3).

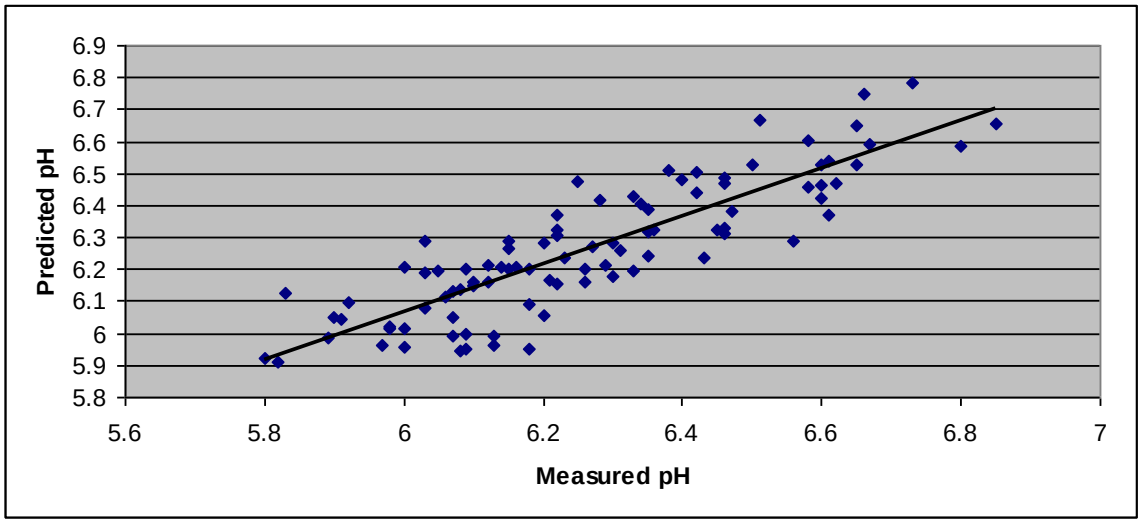

Figure 3: Calibration of beef installation.

This exercise has identified some minor changes that are required to the software and these are currently underway. As the plant is due to shut down within 3 weeks, the software upgrade will be installed during this period and validated once the plant resumes the prime kill in October.

2. Ultimate pH prediction

Two plants have installations intended to test the ability to predict ultimate pH. One is a high throughput sheep plant (25 carcasses/min) and one a hot boning beef plant.

An increase in ultimate pH in chilled export lamb affects microbial growth and accelerates product spoilage. However, individual ultimate pH measurements in lamb is too time consuming and expensive. In beef, ultimate pH is often a product specification and can have a more significant effect on product quality than in lamb. In the case of hot boned processing, direct measurement of ultimate pH is a problem because the product is normally packaged before ultimate pH is reached. There is therefore a strong incentive to define the ultimate pH and allow high pH product to be segregated.

A significant difficulty in ultimate pH studies is the relatively limited incidence of high pH; typically figures run at less than 10% of ultimate pH values greater than 5.8. This means very significant numbers of measurements are needed to enable a significant sampling of high ultimate pH values to be collected.

TRIAL SITE 3:
The ultimate pH measurements were carried out by the plant QA staff, who typically measure 10-20 carcasses per week and collect the associated Smart Stim data files. A total of 473 samples have been collected.

Ultimate pH predictions showed many similarities to those described previously for ultimate pH predictions at trial site 1. The initial analysis using all samples did not produce a sufficient correlation to offer an effective commercial application (r^2: 0.31). However, further investigation showed that the cause of the weak correlation was a

population of carcasses with normal ultimate pH which show minimal responsiveness to the stimulation throughout, particularly at the first set of test pulses. Further interrogation has shown that these are derived from carcasses that have a low initial pH and which do not produce a sufficiently informative response to allow an ultimate pH prediction to be made.

If the dataset is filtered to remove the carcasses with low initial responses (lowest 14% of responses), then the ultimate pH prediction improves markedly (r^2: 0.70). This would be adequate to, for example, segregate carcasses above and below ultimate pH 6 with an acceptable level of accuracy (Figure 3) and would be a commercial benefit to processors who process for the chilled export High Quality Beef market where the pH limit is above 6.0.

However, the present requirement is to identify the causes of unresponsive carcasses. Some of these can be attributed to operational effects that cause the pH to fall unusually rapidly: excessive stimulation during immobilisation, line stoppages, detains etc. However, this does not explain all cases and there appear to be carcasses that are unresponsive, in some cases without particularly low muscle pH. As part of the introduction of the SS system to control pH decline during stimulation as recently implemented at this plant (see above), data on this phenomenon and possible solutions are being investigated.

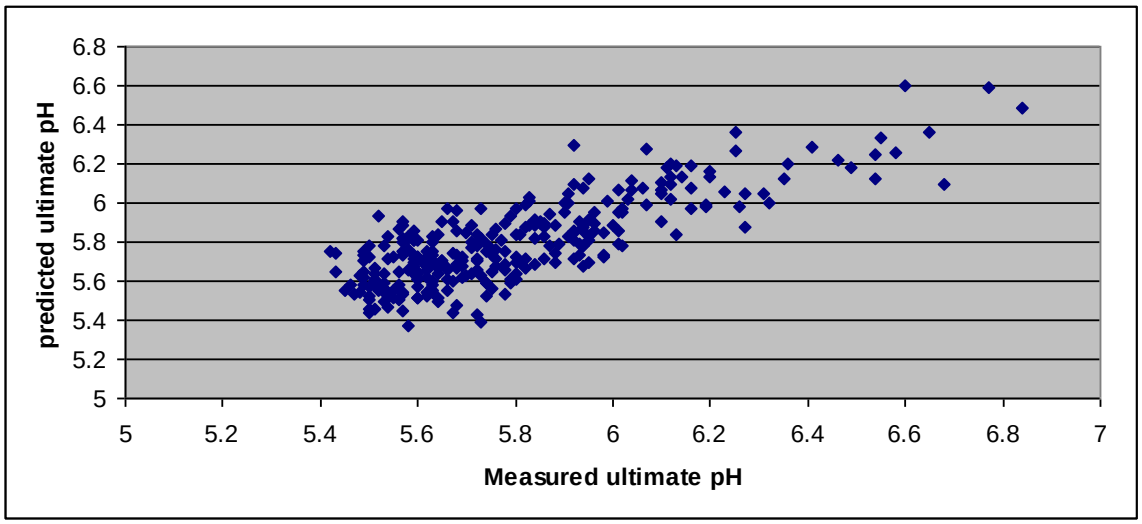

Figure 4: Ultimate pH prediction – filtered dataset.

TRIAL SITE 4

The sheep line operates at 25 carcasses per minute and stimulates the carcasses for 60 seconds. Four sets of test pulses are administered at 15 second intervals. In collaboration with plant QA personnel, a total of 734 carcasses have been used to derive ultimate pH and carcass responses.

Significant effort went into optimising the hardware to ensure that good responses could be recorded: in particular, this installation suffered from difficulties in controlling bouncing of the carcasses when the carcasses were first electrified on reaching the electrodes.

In spite of good management of the responses, the ultimate pH prediction on this sheep installation has so far proved to be ineffective for commercial purposes (r^2 = 0.31). The reasons for this are unclear at this stage. Discussions are currently underway with the plant to evaluate the feasibility of using an alternative test pulse routine to see if a better prediction can be achieved.

Recommendations

While the Smart Stimulation can be used to effectively control the pH decline further work is required to improve the accuracy of the ultimate pH prediction for both beef and lamb. This is an important commercial requirement of the system for both the current commercial installations and also the wider application, particularly relating to hot boning plants.