Final Report

AMPC
AUSTRALIAN MEAT PROCESSOR CORPORATION

Automated Beef Splitting

Automated Beef Slaughter Splitting Translation Project - Cleaning Validation Trials

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Contents

1.0 Executive Summary

As a precursor to the installation of a fully robotic splitting saw at an Australian beef plant a trial was undertaken to determine the effect of an automated wash system on carcase hygiene. A manually operated splitting saw was fitted with a Jarvis automated saw cleaning system and installed at an Australian export beef establishment. In order to address regulatory requirements a hot water wash was incorporated into the system. Regulations in Australia and the EU require equipment to be sanitised between carcases when contact occurs before final disposition. While in the US, equipment need only be sanitized when necessary. A trial carried out at the participating establishment found no significant difference in the microbiological load on carcases processed using the automated system and those processed normally. It is recommended that further trials are undertaken to determine if there is an increase in the spread of contamination over an entire shift and to see what effect increasing the hot water application time has on carcase hygiene. Future trials should consider how heavily soiled or contaminated carcases should be treated.

2.0 Introduction

The Jarvis robotic beef splitting saw is a high-performance machine that Jarvis claim can accurately and consistently split beef carcases. The saw incorporates an automated wash system that cools the saw during operation and helps remove bone dust and other material between carcases. Prior to installation of a fully robotic system at an Australian establishment it would be prudent to demonstrate to processing facilities, and relevant authorities, that the proposed automated saw cleaning system is equivalent to current practice. Further, a review of current regulatory requirements both in Australian and in major trading partners was undertaken to determine if there are any impediments to the installation of robotic splitting saws in Australian establishments.

While robotic splitting saws have already been installed in establishments in the United States there no literature was found on the hygienic performance of the proposed automated wash system. Therefore, a trial was undertaken (and reported here) to evaluate the operation of the cleaning system and to demonstrate that the hygienic outcome is equivalent to current practices. A manual beef carcase splitting saw was retrofitted with the automated cleaning system and installed at an Australian export beef establishment. Removal of specific risk material (SRM) was not evaluated nor was any assessment on the effect on product shelf-life undertaken.

3.0 Project Objectives

Demonstrate via an independent third party that the automated cleaning system as utilised on the Jarvis robotic beef splitting saw provides an equivalent hygienic outcome to current manual saw cleaning procedures.

4.0 Methodology

4.1 Regulatory Approval

4.1.1 United States (US) Approval

Jarvis US was contacted regarding USDA Food Safety and Inspection Service (FSIS) approval of robotic splitting saws incorporating automated wash systems. No examples of approvals were forthcoming. It seems that the FSIS do not approve individual pieces of equipment and have adopted an outcome-based approach, with approval given

on a plant-by-plant basis at the discretion of FSIS on-plant staff. Sanitizing of splitting saws is mentioned in FSIS Directives (Food Safety and Inspection Service, 2011) and Guidelines (FSIS-GD 2021-0008, 2021).

4.1.2 European Union (EU) Approval

EU regulations were reviewed for requirements relating to washing and sanitation of equipment, in particular splitting saws. Regulations (EC) 852/2004 and 853/2004 deal with hygiene of food in general and are relevant to washing and sanitising of equipment used in slaughterhouses.

4.1.3 Department of Agriculture, Water and the Environment (DAWE) Approval

A Letter detailing the project objectives and proposed methodology was forwarded to the department by AMPC late in 2021. A follow-up letter with a revised project methodology was forwarded to the department by the participating establishment early in 2022. Based on these communications the department approved a trial of the automated wash system. A review of the Standards Australia AS 4696:2007 and the Department of Agriculture, Water and the Environment (2015) construction guidelines was also undertaken to identify cleaning/sanitation requirements for equipment.

4.2 Equivalence Trial

4.2.1 Splitting saw operation

A Jarvis manual splitting saw was fitted with an automated wash system similar to that used in the Jarvis robotic splitter. The saw was installed at the participating establishment. The system delivers a cold-water wash followed by a 4-second hot water rinse at preprogramed times during operation. Wash water was applied as outlined in Figure 1.

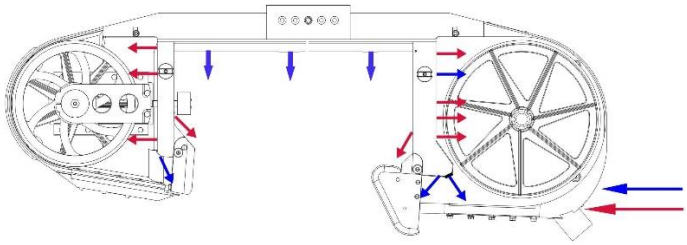

Figure 1: Schematic of operation of Jarvis automatic wash system. Red arrows show hot water outlets, blue arrows show room temperature water outlets. Large blue and red horizontal arrows show cold and hot water inlets, respectively. The vertical blue arrows above where the blade would be situated do not deliver water under pressure but rather supply a steady stream of water as part of the blade cooling process.

The normal manual wash system consisted of cold-water cooling/washing during operation (as per the automated system) followed by sanitising using 82 °C water applied in a wash cabinet for 10 seconds. No manual cleaning of accumulated bone dust was undertaken under either system for the purpose of the trial.

4.2.2 Hygienic Assessment

Carcase hygiene samples were collected from alternate sides immediately after splitting with and without the automated wash system. Samples were collected by establishment staff under the direct supervision of the author. Twenty sides were sampled for each procedure. The automated wash system was run first followed by the normal washing system. Sampling commenced in the morning and 35 animals were sampled before there was a 30-minute

break in production. The final 5 carcases were sampled after the break. The splitting saw received a wash down during the break.

Sampling sites were selected based on where the saw contacted the carcase surface and after discussions with the department on-site veterinarian. Swab samples were taken using Whirl-Pak™ cellulose sponges from three 100 cm^2 sites on each side, as defined in Figure 2.

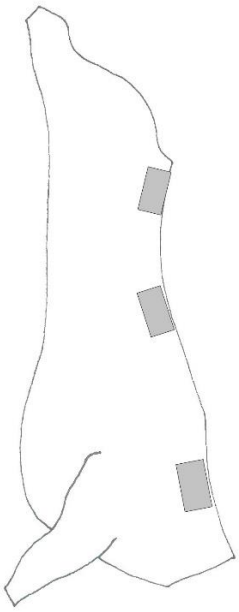

Figure 2: Rump, loin and neck sample sites on the external surface of beef carcases adjacent to the mid-line.

Briefly, sponges were rehydrated in ~5 ml of buffered peptone water (BPW) prior to sampling. At each of the sample sites the area to be sampled was defined by a 10x10 cm stainless steel template. The template was sanitised in 82 °C water between carcases. A single swab was used to sample the three sites on the carcase (rump, loin and neck in that order). Samples were taken by rubbing the swab over the defined area 10 times vertically and 10 times horizontally rotating the sponge after the first two sample sites. Samples were then stored in a non-refrigerated container until taken to the lab for processing. At the lab BPW was added to each sponge sample to bring the total volume of diluent added to 25 ml. Samples were sealed and placed in a refrigerated container awaiting shipment to the testing laboratory. Samples were processed at a NATA (National Association of Testing Authorities) accredited (ISO 17025) testing laboratory on the day following sample collection. Samples were analysed for aerobic plate count (APC) and *E. coli* / coliforms using Petrifilm™ following the procedures detailed in AOAC 990.12 and AOAC 998.08/991.14, respectively. Counts were normalised by transforming to $\log_{10}$ of the number of colony forming units (CFU)/cm^2 prior to statistical analysis using R (RStudio Team, 2016; Boston, MA) and Minitab14™ (Minitab Inc., State College, PA).

5.0 Project Outcomes

5.1 Regulatory Requirements

A review of USDA FSIS PHIS Directive 6410.1 (Foos Safety and Inspection Service, 2011) found reference to a requirement for cleaning and sanitizing of splitting saws and knives between carcases, however, this seems to have been relaxed in later guidelines. Guideline, FSIS-GD 2021-0008 (2021) clarifies that sanitizing of the splitting saw should be done as necessary or after each use on suspect, retained, or obviously diseased carcases.

EU regulations dealing with food hygiene specify that carcases that have not received post-mortem inspection should not contact other carcases but do not detail requirements for the cleaning of equipment between carcases (Regulation (EC) 853/2004). Further, Regulation (EC) 852/2004 requires equipment contacting meat to be cleaned and, where necessary, disinfected at a frequency sufficient to avoid any risk of contamination. This is supported by the European Communities (Fresh Meat) Regulations (1997) that require equipment to be cleaned and disinfected several times during the working day, at the end of the day's work and before being reused when they have been soiled.

Standards Australia AS 4659-2007 requires equipment to be cleaned and sanitised if it contacts a carcase or carcase part that has not been given a post-mortem disposition and there is a risk that such contact could result in contamination of product intended for human consumption. The Department of Agriculture, Water and the Environment (2015) construction guidelines are more prescriptive requiring sanitising of the splitting saw between carcases that have yet to undergo fronts-inspection. It should be noted that these guidelines are unchanged from those published in 1988.

5.2 Hygienic Outcomes

In general, the trial went smoothly with samples being collected with little impact on production. When initially installed the automated wash system delivered a cold-water wash as soon at the saw was engaged. A timer was later installed to delay application of cold water until the saw had cleared the pelvic channel. This was to address concerns from the department about the spread of contamination if water is applied to soon. The automated wash system operated to Jarvis specifications for the trial. There was some concern over the length of time that the hot water sprays were applied. Currently the hot wash sprays are initiated (once the operator releases the saw’s trigger) for 1-4 seconds. It was noted that, when set for a 4-second application, the external sprayers at either end of the cutting blade hardly got up to pressure before the cut-out switch turned off the water supply. This can be adjusted in future trials if necessary.

There was build-up of bone dust on the saw guide after the first few carcases were processed under both systems, however, the amount of bone dust seemed to level out, with excess sloshing off onto the floor (Figure 3). Without manual hosing of the saw neither wash system removed all bone dust from the saw housing and contact surfaces between carcases.

Figure 3: Splitting saw in operation showing build-up of bone dust and other material on the saw during operation.

There was no significant difference (p=0.28) in the APC on carcases split with the automated wash system (μ= 9.6 CFU/cm^2; 0.98 log$_{10}$ CFU/cm^2) and those split with the normal wash system (μ= 5.9 CFU/cm^2; 0.77 log$_{10}$ CFU/cm^2) (Figure 4). The APC on samples collected immediately after a break tended to be slightly higher than on samples collected later in the shift. It is not clear if this was an anomaly or indicative of production at this establishment. This may have confounded the results in favour of the normal wash system where the break was towards the end of sampling. Future trials should be designed with this in mind.

There was no significant difference in the prevalence (p=0.5) or numbers (p=0.14) of coliform bacteria on normally split carcases (6/20) and those split with automatic washing (8/20). The overall level of coliforms was low, ~0.2 CFU/cm^2. Only one sample from a carcase split with the automated wash system was found positive for *E. coli* (at the limit of detection i.e., 0.083 CFU/cm^2).

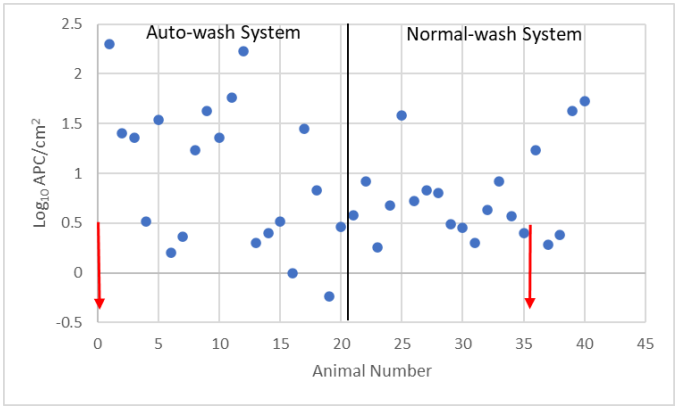

Figure 4: Log$_{10}$ APC per cm^2 on beef carcases after splitting with the automated wash system (left) and with the normal wash system (right). Red arrows show breaks in production.

There was a tendency for the Log_{10} APC on carcases to decrease over time for carcases split with the automatic wash system and increase over time for carcases split with the normal wash system (Figure 5). Again, this may be confounded by the effect of production breaks on carcase hygiene.

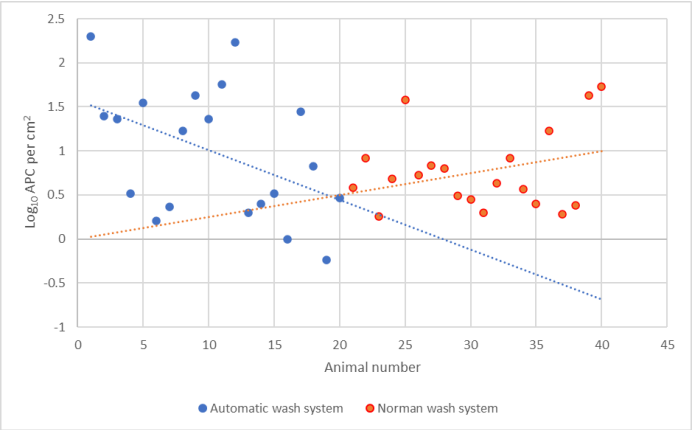

Figure 5: Log_{10} APC per cm^2 on beef carcases after splitting with the automated wash system (blue circles) and with the normal wash system (red circles). Dotted lines show liner regression fits for data from each wash system.

6.0 Discussion

It would appear that there may be some regulatory resistance for implementation of an automatic wash system that does not include an effective sanitation step, particularly under current Australian and EU requirements. An equivalence position could be argued based on the results of this trial and further strengthened by increasing the hot water application time. The hygienic outcome, as measured by the bacterial load on carcases, was not significantly different between carcases processed using the automated wash system and carcases processed using the normal wash system. This was not surprising as the general hygiene of carcases processed at the trial establishment was excellent making the transfer of significant numbers of bacteria between carcases unlikely. The system may be tested when heavily contaminated or soiled carcases are processed, however, such carcases can be detected before splitting and appropriate cleaning/sanitizing procedures implemented after splitting to ensure that contamination is not spread to trailing carcases. Increasing the hot water application time may aid in reducing the spread of contamination.

7.0 Conclusions / Recommendations

The trial demonstrated that beef carcases can be hygienically split using the Jarvis automated wash system. It is recommended that further trials are undertaken to determine if there is an increase in the spread of contamination over an entire shift and to see what effect increasing the hot water application time has on carcase hygiene. Future trial should also look at how heavily soiled carcases should be processed.

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