Final report

Alternate time/temperatures for the sanitation of knives

Project code: V.MFS.0451

Prepared by: Paul Vanderlinde
Vanderlinde Consulting Pty Ltd

Date published: 28th May 2024

PUBLISHED BY
Meat & Livestock Australia Limited
PO Box 1961
NORTH SYDNEY NSW 2059

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

Abstract

Traditionally knives and other items of equipment that contact product are first rinsed to remove gross contamination and then sanitised in 82 °C (180 oF) water. The reduction in bacterial numbers achieved by this practice has not been communicated by regulators. It is proposed that alternate time/temperatures can produce and equivalent outcome. A review of published studies found that traditional knife sanitation practices result in at most a 3-log reduction in bacterial numbers. Based on published studies it is proposed that the following combinations of time and temperatures can produce an equivalent outcome.

Temperature (°C)	Time (s)
75	2
74	2
73	2
72	3
71	4
70	5
69	7
68	9
67	11
66	15
65	20
64	26
63	36
62	48
61	66
60	90

Establishments can use this data to implement changes to their approved arrangement following the process below.

- Select a time/temperature combination that achieves an equivalent outcome.
- Undertake a verification study (Appendix 1) to demonstrate compliance with the criteria selected.
- Modify Approval Arrangement to include changes to processing, monitoring practices and corrective actions, subject to importing country requirements.

Table of contents

1. Background

Traditionally knives and other items of equipment that contact carcasses prior to inspection are first rinsed to remove gross contamination and then immersed briefly in 82 °C (180 oF) water. This process is carried out in knife 'sterilisers' distributed along the slaughter chain. It is generally acknowledged that the term 'steriliser' is misleading, and that sanitiser is a more appropriate term. Sanitising of knives is carried out between carcasses to help prevent cross-contamination between potentially diseased carcasses and trailing carcasses. The origin for use of 82 °C water appears to be the US where in the 1950's the USDA determined that dipping carcass-splitting saws in 82 °C water killed sufficient numbers of microorganisms to satisfy regulatory requirements. However, what constitutes a satisfactory reduction in microorganisms has not been articulated. Further, it is well understood that the effectiveness of thermal interventions is dependent on both the temperature of treatment and the exposure time. The time of emersion in 82 °C water necessary to achieve the desired food safety outcome has never been reported. The following report summarises published studies on knife sanitation in meat establishments and proposes alternate time/temperatures that provide an equivalent outcome to traditional practices.

2. Objectives

To define the efficacy of current knife sanitisers and present an equivalence argument for the use of alternate time/temperature regimes for the sanitation of knives in the meat industry.

3. Methodology

A critical review of published peer reviewed papers on knife sanitation using both traditional and alternate regimes was undertaken. Based on the results of this review recommendations are made for the use of alternate time/temperatures for the sanitation of knives in Australian slaughterhouses.

4. Discussion

4.1 Traditional knife sanitation

Industry currently sanitisers knives by briefly dipping in 82 °C water. This process is considered to satisfactorily meet the desired food safety objective even though a quantitative outcome has never been defined. It is likely that the practice of briefly dipping knives was adopted because of time limitations imposed by high chain speeds. While the efficacy of briefly dipping in 82 °C water has not been articulated by regulators a number of published studies have attempted to quantify the reduction in bacterial numbers achieved by this process. Bell and Hathaway (1996) reported a 2.62 log reduction (99.8%) in the aerobic plate count (APC) on knife blades sanitised by first cleaning (hand wash) followed by briefly dipping in 82 °C water (estimation of exposure time not provided). Similarly, Goulter et al (2008) observed a 3.44 log reduction in Escherichia coli numbers inoculated onto knife blades pre-rinsed and then sanitised at 82 °C for 1s. Durmuşoğlu et al (2020) reported a 3.05 log reduction in APC and a 2.1 log reduction in Enterobacteriaceae on knives sanitised at 82 °C for 5s, although it is not clear if knives were rinsed to remove visible contamination prior to treatment. Goulter et al (2008) mentions a 3-log reduction as a possible criterion for assessing equivalence to dipping in 82 °C water, but questions if such a criterion can be routinely met, concluding that a 2-log reduction would meet sanitary requirements. From the limited published

data, it would appear that a 3-log reduction is more in-line with the outcome achieved by dipping in 82 °C water following a pre-rinse. It is proposed that a 3-log reduction be used as the performance criterion for assessing equivalence of alternate time/temperatures for knife sanitation.

4.2 Effect of pre-rinse

All studies report a benefit in removing visible contamination with a pre-rinse in warm water prior to sanitising. Bell and Hathaway (1996) showed that hand washing of knives alone, with 44 °C water, resulted in a 1.75 log (98%) reduction in APC. Goulter et al (2008) observed that a 40 °C pre-rinse resulted in an additional 1.39 log reduction in E. coli numbers compared to simply dipping in 82 °C water. Snijders et al (1985) observed a ten-fold difference in the effective treatment time (1s to 10s) for knives emersed in 82 °C with or without a pre-rinse. In most cases it will be necessary to pre-rinse knives prior to sanitising.

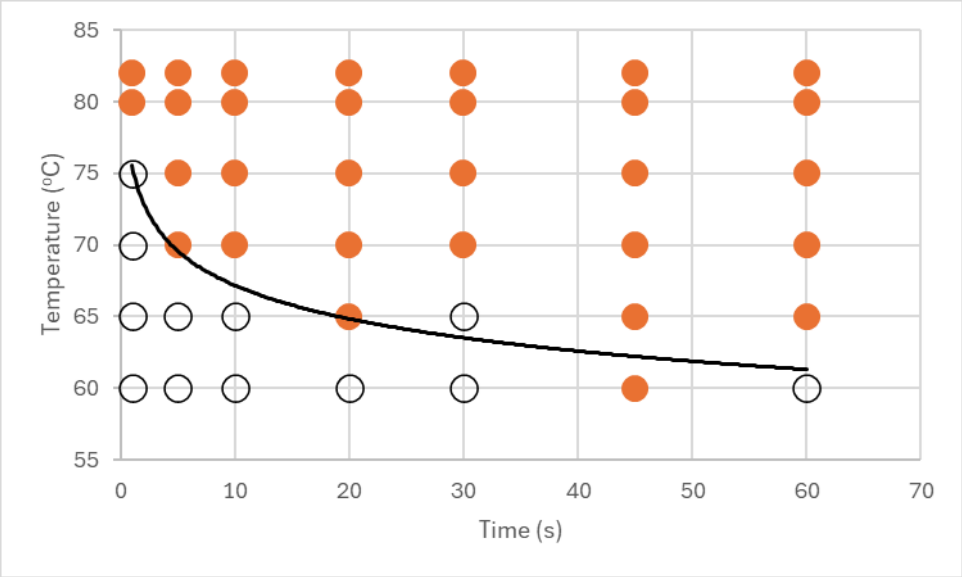
4.3 Regulatory requirements

The European Commission adopted an Opinion of the Scientific Committee on Veterinary Measures relating to Public Health on the cleaning and disinfection of knives in the meat and poultry industry (SCVPH, 2001). The committee observed that pre-rinsing of knives was essential to achieve the desired level of disinfection no matter what the process. The Australian standard requires meat handlers to clean and sanitise work implements using 82 °C water or equivalent method as necessary to prevent contamination (AS 4696:2023). US regulations (CFR 9, 416.4) require utensils and equipment to be cleaned and sanitised as frequently as necessary to prevent creation of insanitary conditions or adulteration of product. The US seem to have stepped back from prescribing use of 82 °C water leaving it up to establishments as to how they achieve the sanitary outcome required. EU Regulation (EC) 853/2004 requires industry to have facilities for disinfecting tools with hot water supplied at not less than 82ºC, or an alternative system having an equivalent effect.

4.4 Alternate time/temperatures for knife sanitation

There are numerous studies on alternate time/temperatures for sanitising knives. Unfortunately, most do not quantify the outcome. Eustace et al (2007) found fewer bacteria on knives treated at 60 °C for 30s than on knives dipped in 82 °C water (both with a pre-rinse). Alternate procedures have been shown to have a similar outcome to the current practice of rinsing followed by dipping in 82 °C water. Leps et al (2013) reported a 3.2 log reduction in APC on inoculate steel plate when emersed in 70 °C water for 5s and a 3-log reduction at 60 °C after 53s (estimated from their Figure 1). Goulter et al (2008) present the most comprehensive data set for alternate time/temperatures. A summary of their published data, highlighting time/temperature combinations that result in a 3-log or greater reduction in bacterial numbers, is provided in Figure 1.

Figure 1: Time/temperature combinations resulting in a 3-log or greater reduction in E. coli numbers. Adapted from the data in Table 2 of Goulter et al (2008). Solid circles are combinations that resulted in a ≥3-log reduction in E. coli numbers, open circles are combinations that did not result in a 3-log reduction. The solid line represents the boundary for effective sanitation determined by regression analysis of individual temperature data.



The boundary line in Figure 1 suggests effective treatment times at temperatures of 70 °C and 60 °C of 5s and ~60s respectively, this agrees fairly closely with the observations of Leps et al (2013) mentioned previously. Operating sanitisers at 60 °C appears to produce ambiguous results and is not recommended at times of less than 60s.

5. Conclusion

It is proposed that the simplified time/temperature matrix detailed in Table 1 (derived from the boundary line in Figure 1) be adopted as providing an equivalent outcome to the current practice of rinsing followed by momentary dipping in 82 °C water.

Table 1: Recommended alternate time/temperature combinations that give an equivalent outcome to dipping in 82 °C water. Combinations assume that knives have been rinsed prior to treatment to remove gross contamination. Times given have been rounded up to the nearest second.

Temperature (°C)	Time (s)
75	2
74	2
73	2
72	3
71	4
70	5
69	7
68	9
67	11
66	15
65	20
64	26
63	36
62	48
61	66
60	90

Times for a 3-log reduction on knives treated with hot water alone (i.e. no pre-rinse) were 2 to 5 times longer than times with a pre-rinse i.e. 10s at 70 °C. As no allowance has been made for the effect of any build-up of protein and fat on knives not subjected to a pre-rinse it is recommended that all treatments include a pre-rinse in handwash water. In order to implement an alternate program for sanitation of knives it is recommend that establishments follow the general protocol outlined by the Meat Standards Committee (MSC) paraphrased below.

- An independent scientific assessment of the proposed operating conditions. The recommendations in this report can be used in lieu of a formal scientific assessment. and provided to the authorities in an equivalence submission. An independent assessment may be required if not applying a pre-rinse.
- Verification that establishments can operate in accordance with the proposal (through a supervised pilot study, Appendix 1).
- Approval of an arrangement that demonstrates the capacity of the establishment to operate in accordance with the proposal, subject to importing country requirements.

6. References

AS 4696:2023. Australian Standard for the Hygienic Production and Transportation of Meat and Meat Products for Human Consumption. CSIRO Publishing, Collingwood, Vic., Australia, 2023.

Bell, R. G. and Hathaway, S. (1996). The hygienic efficiency of conventional and inverted lamb dressing systems. Journal of Applied Bacteriology 81(3):225-234.

CFR 9. Code of Federal Regulations (CFR) Title 9 - Animals and Animal Products, Chapter 3, Subchapter E, Part 416.4 - Sanitary Operations.

Durmuşoğlu H, İncili GK, Demir P, İlhak Oİ. (2020) Effects of workers' hand washing and knife disinfection practices on microbiological quality of small animal carcasses in slaughterhouse environment. Journal of Food Processing and Preservation 44:14918.

EU Regulation (EC) No 853/2004 of the European Parliament and of the Council of 29 April 2004 laying down specific hygiene rules for food of animal origin. Chapter 2 Requirements for Slaughterhouses, Item 3.

Eustace, I., Midgley, J., Giarrusso, C., Laurent, C., Jenson, I. and Sumner, J. (2007). An alternative process for cleaning knives used on meat slaughter floors. International Journal of Food Microbiology, 113:23-27.

Goulter, R. M., Dykes, G. A. and Small, A. (2008). Decontamination of Knives Used in the Meat Industry: Effect of Different Water Temperature and Treatment Time Combinations on the Reduction of Bacterial Numbers on Knife Surfaces. Journal of Food Protection 71(7):1338-1342.

Leps, J., Einschütz, K., Langkabel, N. and Fries, R. (2013). Efficacy of knife disinfection techniques in meat processing. Meat Science 95:185–189.

SCVPH, (2001). The cleaning and disinfection of knives in the meat and poultry industry. Opinion of the Scientific Committee on Veterinary Measures relating to Public Health. European Commission, Health & Consumer Protection Directorate General.

Snijders, J.M., Janssen, M.H., Corstiaensen, G.P., and Gerats, G.E. (1985). Cleaning and disinfection of knives in the meat industry. Zentralbl Bakteriol Mikrobiol Hyg B. 181(1-2):121-31.

7. Appendix 1: Example of Verification Study Design

The following steps should be taken prior to implementing an alternate procedure.

- Audit of the current process to determine the minimum emersion time achievable at each workstation.
    - The current procedure at each workstation should be documented i.e. one or two or more knife system.
    - It is recommended that three observations be carried out at each station on three separate occasions throughout the working day.
    - The minimum possible emersion time should be recorded for each station.

- Implementation of selected treatment time
    - Once a minimum emersion time has been determined at each station changes to the SOPs should be made detailing how this time will be met i.e. operator training, implementation of a two or more knife system etc.
    - Alternate emersion times and associated procedures should be implemented initially using 82 °C water. This should be run over several days with increased monitoring and verification of emersion times by staff and the OPV/FSO.
    - Changes should be made to the SOPs as required.
    - Corrective actions in the event of a failure should be documented in the SOP, this should account for where along the chain the failure occurred.
- Alternate time/temperatures for knife sanitation
    - Implement the selected time/temperatures at each workstation.
    - Verify water temperature at each station prior to commencement of work.
    - Monitor treatment times and water temperatures throughout the day.
    - Undertake routine monitoring of time/temperatures as per current frequency agreed to by the controlling authority.