SANITIZING KNIVES USED IN THE MEAT INDUSTRY – EFFECT OF DIFFERENT TIME/TEMPERATURE COMBINATIONS

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Introduction

In Australia and internationally knives used during the slaughter and dressing of carcasses are sanitized in water at 82ºC (Eustace *et al.* 2007, Taormina and Dorsa 2007). The scientific basis for the use of the 82ºC temperature is not clear and appears to be based on convention established from previous regulatory practices rather than from empirical data. A number of studies have indicated some issues with the use of hot water as a sanitizer and in particular the role organic matter on knives can have in reducing the effectiveness of this practice (Peel and Simmons 1978, Snijders *et al.* 1985). Furthermore, it has been suggested that meat residue denatured in hot water may act to protect bacteria from subsequent sanitation (Peel and Simmons 1978). In 2001, the European Commission adopted a scientific opinion that 82°C water may not be the best means of sanitizing knives, and that alternative means of sanitizing knives in the meat industry could be investigated (EC 2001).

Recent studies have examined the potential for alternative practices to achieve the same or better reduction in bacterial numbers than the typical 82ºC immersion (Eustace *et al.* 2007, Taormina and Dorsa 2007). The effectiveness of brief immersion at 82ºC in significantly reducing bacterial numbers on knives with meat residue on them was questioned by these studies with 1 log CFU/cm^2 reduction typically observed. A 15s immersion at time in water at 82ºC or warm water containing quaternary ammonium compounds, however, was suggested as being effective in reducing bacterial numbers by ~3 log CFU/cm^2 (Taormina and Dorsa 2007). In a separate study Eustace et al (2007) demonstrated in the laboratory that immersion of knives in 72ºC water for 15s after a rinse in hand-wash water was as effective as rapid dipping in 82ºC water. Eustace (2005) also found that the use of a two-knife system with rinsing in hand-wash water then immersing in 60ºC between uses was as effective as the typical 82ºC system in small slaughter facilities.

In all the above studies limited time-temperature combinations were investigated and an overall indication of the response of bacteria to hot water treatment on knives with meat residue on them was not apparent. This study was undertaken to overcome these gaps in knowledge by establishing the response of an *Escherichia coli* strain on meat-soiled knives to time-temperature combinations ranging from 1 to 60s and 60 to 82ºC.

Materials and Methods

Escherichia coli was grown overnight at 37ºC in Tryptone Soy Broth. 2mL of this culture was added to 150g of ground meat in a stomacher bag and mixed by kneading the bag by hand. Both sides of a knife blade were covered with the meat / culture mixture, ensuring an even coating of meat product on both sides of the knife blade. 28mL of 0.85% saline was added to a sterile Whirlpack sponge, which was then squeezed to remove excess liquid. One side of the knife was swabbed with the sponge. The knife was then immersed in a waterbath at a set temperature for a specific period of time. The times and temperatures used in the treatments were combinations of: Time: 1, 5, 10, 20, 30, 45, 60 seconds and Temperature: 60, 65, 70, 75, 80, 82ºC. All combinations were tested in triplicate, and all combinations were repeated with a 1 second 40ºC pre-rinse prior to immersion of the knife blade.

After the treatment was applied, another Whirlpack sponge prepared in the same way was used to swab the other side of the knife. The Whirlpack sponges were stomachered for 30 seconds. A decimal dilution series was prepared in 0.85% saline, using 0.5mL of liquid from the Whirlpack sponge bags. 1mL of each dilution was plated onto Petrifilm™ *E.coli* / coliform count plates, and these were incubated at 37ºC overnight. Counts were determined, mean log reductions calculated, and the results were analysed by using Tukey's familywise comparison.

Results

The mean log reductions in *E. coli* population on the knife blades, attributable to the different time/temperature combinations are shown in Tables 1 (immersion with no pre-rinse) and 2 (immersion following 1 second pre-rinse in running water at a temperature of 40°C).

Table 1: Mean log reduction in *Escherichia coli* population on knife blade following immersion for different periods of time in water at different temperatures

Immersion	**Temperature (°C)**					
time (sec)	60	65	70	75	80	82
1	$0.47^{a,d}$	$0.68^{a,d}$	-0.02^{a}	$0.36^{a,d}$	2.05^{c}	$1.17^{c,d}$
5	1.40^{e}	$1.71^{e}1$	$1.83^{e}8$	1.97^{e}	3.78^{f}	4.72^{f}
10	1.71^{g}	1.88^{g}	3.81^{h}	4.64^{h}	4.72^{h}	4.81^{h}
20	1.60^{i}	2.57^{j}	2.58^{j}	4.70^{k}	5.29^{k}	4.65^{k}
30	1.73^{l}	$2.45^{l,m}$	$3.48^{l,n}$	5.08^{n}	$3.85^{m,n}$	4.65^{n}
45	1.85^{p}	3.23^{q}	4.77^{r}	5.11^{r}	4.85^{r}	5.02^{r}
60	1.86^{s}	3.75^{t}	4.62^{t}	$4.58^{t,u}$	5.33^{u}	4.93^{u}

Values across rows bearing different superscripts differ significantly at P<0.001

Table 2: Mean log reduction in *Escherichia coli* population on knife blade following immersion for different periods of time in water at different temperatures, after a pre-rinse in 40°C running water

Immersion	**Temperature (°C)**					
time (sec)	60	65	70	75	80	82
1	2.07^{a}	1.92^{a}	1.85^{a}	2.70^{a}	3.41^{a}	3.44^{a}
5	$1.96^{b,e}$	$1.24^{b,d}$	$3.46^{c,e}$	$3.75^{c,e}$	$3.63^{c,e}$	4.56^{c}
10	1.90^{f}	$1.85^{f,g}$	3.51^{h}	4.97^{i}	4.95^{i}	$4.47^{h,I}$
20	2.71^{j}	$3.50^{j,k}$	$4.75^{k,l}$	5.11^{l}	4.91^{l}	$4.74^{k,l}$
30	2.62^{m}	$2.86^{m,n}$	5.29^{p}	4.98^{p}	4.93^{p}	4.83^{p}
45	$3.69^{q,r}$	$3.31^{q,s}$	5.15^{t}	4.91^{t}	5.01^{t}	$4.46^{r,t}$
60	1.53^{u}	4.30^{w}	5.23^{x}	$4.90^{w,x}$	$4.44^{w}6$	$4.78^{w,x}$

Values across rows bearing different superscripts differ significantly at P<0.001

Conclusions

- Different time / temperature combinations could be used to achieve an equivalent reduction in *E. coli* population to that currently achieved using 82°C.
- Immersion of a knife for 1 second at any temperature in the range 60 to 82°C, without a pre-rinse phase, is an ineffective intervention for microbial reduction.
- When pre-rinse is applied, 80 and 82°C can achieve a 3 log reduction in *E. coli* population with a 1 second immersion.
- Without pre-rinse, 80 and 82°C can achieve a 3 log reduction in *E. coli* population when knives are immersed for 5 seconds.
- Without pre-rinse, 75°C will achieve a reduction in *E. coli* population when 10 seconds immersion is used, 70°C will achieve this after 20 seconds immersion.
- Without pre-rinse, 60°C does not achieve more than a 2 log reduction even if the immersion time is extended to 60 seconds. 65°C achieves a 2 log reduction in *E. coli* after 20 seconds.
- With a pre-rinse, immersion at temperatures of 70°C or above will achieve a 3 log reduction in *E. coli* population after 5 seconds immersion.

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