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The Microbiological Status of Condensation in Carcase Chillers

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EXECUTIVE SUMMARY

Condensation in carcase chillers is a continuing problem in many abattoirs, both export and domestic registered. Often engineering solutions are difficult and expensive to implement and condensation can only be controlled by manual mopping. An evaluation of the microbiological status of condensation on both clean and dirty chiller surfaces and steel work was undertaken to assess the bacterial load.

Over a five month period five abattoirs in South-East Queensland and Northern New South Wales were visited by Australian Meat Technology staff. Three were export registered and two were domestic plants. The chillers were visually assessed and samples of condensation were collected for microbiological assessment. Heavily soiled evaporators were cleaned in one plant to determine the effect of cleaning on the microbial status of both the evaporators and the chiller air.

The amount of condensation present in the chillers varied greatly. In some instances large volumes were able to be collected whereas in other cases it was not possible to collect enough sample to accurately undertake analysis.

Where chillers were kept in a clean and hygienic manner there was no evidence of the presence of coliforms or *E. coli* in the condensation. However, for some chillers which were in need of maintenance cleaning, the condensation collected was contaminated with coliforms.

Manual cleaning of evaporators and fins reduced the bacterial load present although it appeared to have little effect on the overall level of airborne bacteria during limited monitoring. Due to the limited scope of this project the long term effect of cleaning evaporators on the airborne bacterial load, could not be assessed.

INTRODUCTION

Condensation in carcase chillers is a continuing problem in many abattoirs, both export and domestic registered. Often engineering solutions are difficult and expensive to implement and condensation can only be controlled by manual mopping. The question has been raised by industry concerning the microbiological status of condensation on clean chiller surfaces and steelwork and whether this is likely to have any effect on the microbiological quality of the carcases.

An investigation into the microbiological status of condensation in chillers was undertaken by Australian Meat Technology. The investigation focused on the determination of the incidence of coliforms and *E. coli* in condensation collected from various chillers. The effect of cleaning on the microbiological load present on chiller evaporators was investigated. The microbiological status of the air circulating around the chiller was also assessed.

METHODS AND EQUIPMENT

Over a five month period five abattoirs in South-East Queensland and Northern New South Wales were visited by Australian Meat Technology staff. Three were export registered and two were domestic plants. Some plants were visited on several occasions. On each visit the condition of the chillers was assessed and samples of condensation were collected for microbiological assessment. Air samples were collected from inside some chillers using a Microban Air Sampler.

Visual Assessment of Chillers

Each chiller was assessed according to a set list of criteria. These included the general condition and appearance of the chiller and the presence and level of mould, rust or dirt in the chiller. The presence and level of condensation on the ceiling and rails was determined. Other factors noted included the frequency of chiller cleaning, the cleaning program used and the time since the chiller was last cleaned along with the age of the chiller and general construction materials.

The type and condition of the evaporators and fans in each of the chillers were assessed and the level of dirt and grime build-up on the fans and fins of the evaporators was noted.

Evaporator Cleaning

Heavily soiled evaporators were cleaned in one plant to determine the effect of cleaning on the microbial status of both the evaporators and the chiller air.

The cleaning program involved the use of a suitable chlorinated detergent and mechanical action to remove surface grime and build-up. The refrigeration units and fans were switched off, the fins and fan blades hosed and a commercial grade detergent was sprayed on. The area was lightly scrubbed using a nylon brush, to assist in the removal of the soil and then hosed to rinse off the detergent. The refrigeration units were allowed to drain before being operated again.

Microbiological Assessment

Condensation

On each visit to the plant, samples of condensation were collected from various areas in the chiller. The sampling areas included the ceiling, underside of the evaporator drip trays, supporting steelwork and around the door frames.

Samples of condensation were collected using a pre-weighed sterile Microdiagnostic™ sponge in a plastic bag. Samples were collected by carefully dabbing the area of condensation, and allowing the condensation to fall or drip into the bag, or be soaked up by the sponge. Where the samples were in a difficult to reach area the sponge and bag were clipped on to an extension pole.

After the samples were collected, the sponge and bag were weighed and the weight of the condensation was calculated and recorded. Duplicate samples of 1 mL of the condensation were then plated directly on to 3M Petrifilm ™ for the enumeration of *E. coli* and coliforms.

Evaporators

Surface samples were collected from the evaporators, before and after cleaning, using sterile cotton swabs moistened with Butterfields diluent. For each evaporator the swab was inserted between the fins and a surface area of approximately 25 cm^2 was sampled. The swab was then placed into the tube of 9 mL diluent. Duplicate samples of 1 mL of the diluent were plated directly on the 3M *E. coli* Petrifilm ™ for the enumeration of *E. coli* and coliforms and on to 3M TVC Petrifilm ™ for the determination of the total viable count.

Air sampling

Samples of the air inside the chillers were collected using a Micoban air sampler. A sterile petri dish containing standard plate count agar was place inside the air sampler. Air was then drawn into the unit for 5 minutes. The plates were incubated for three days at 25°C.

RESULTS AND DISCUSSION

Visual Assessment

Plant One - Export

The overall condition of the twelve chillers and evaporators in this plant was very good. Two of the chillers had been newly commissioned and another two were less than two years old. The remaining chillers were over twenty years old.

There was no visual presence of moulds in the chillers, nor was there presence of rust on the steelwork, walls or ceilings.

The plant undertakes a daily program of hosing the walls and floor of the chiller after the carcases are loaded out and before reloading.

The new chillers had little condensation, while considerable quantities of condensation were present in the older chillers. This was probably due to the newer rooms having better insulation, higher refrigeration capacities and better air circulation. The newer chillers had a different pattern of air circulation, with the air being supplied near floor level from a plenum in the wall, and returning to the fans near the ceiling. The older chillers had standard evaporators mounted in the room above the rails, a design which can lead to condensation build-up on the underside of the evaporator drip tray.

Plant Two - Domestic

The overall condition of the four chillers assessed at this plant was poor. The chillers were up to 25 years old and all had the evaporators mounted in the space above the rails. There was a large amount of condensation present in all chillers, particularly on the ceilings and there was evidence of some rust on the rails and supporting steelwork. Some of the condensation in these chillers remained from chiller washdown with hot water, as the rooms were not mopped or dried out after hosing. Some of the condensation was due to moisture being blown off the evaporators coils. In other cases the condensation was due to warm moist air entering from the slaughter floor.

Plant Three - Domestic

The physical condition of the two chillers at this plant was excellent. The plant had undertaken a rigorous cleaning program one month before the trial commenced, so the general hygiene of the chillers was excellent. There was, however, considerable condensation present on the ceiling and under the evaporator drip tray in one of the chillers. The condensation was due to warm moist air entering from the slaughter floor, as carcases were loaded directly off the floor into the chillers.

Plant Four - Export

Condensation mainly occurred in two chillers at this plant. All chillers were in good condition with the floors and walls being hosed daily between loads and the ceilings

cleaned periodically. The main area where condensation occurred in one of the chillers was on the ceiling near the entry from the slaughter floor, due to the ingress of moist air. In the other chiller it occurred mainly on the fan cowling of the evaporator.

Plant Five - Export

The chillers assessed at this plant were over 20 years old. Their overall condition was good. The plant undertakes a daily cleaning program with the floor and walls being hosed between loads and the ceilings cleaned periodically. There was no evidence of moulds or rust in any of the chillers assessed.

There was insufficient condensation available to sample in the chillers. This could be attributed to location with respect to the kill floor, adequate refrigeration capacity and good air circulation. The chillers were remote from the slaughter floor, minimising the inflow of warm moist air. The refrigeration system was designed with large evaporators to provide more than adequate refrigeration and good air circulation throughout the chillers.

General comment

When condensation occurred in chillers, it most commonly appeared on the ceilings and steelwork, especially in the area directly adjacent to the loading door. The underside of evaporator drip trays was also a common site for condensation and was due to lack of insulation or poor insulation on the drip tray. Condensation was also detected on the metal door frames and was due to the interface between warm and cold areas.

The amount of condensation present in the chillers varied greatly. The chillers of two of the plants visited had a large volume of condensation, (60 - 70 mL per area sampled). The largest quantities were obtained from ceilings and the underside of evaporator drip trays. In one of the plants visited it was not possible to collect more than one or two mL of condensation.

Several other plants were inspected, but insufficient condensation was available for sampling and analysis.

Microbiological Assessment

Condensation

The microbiological results from samples of condensation which were able to be tested from export plants are presented in Table 1. The results for domestic plants are presented in Table 2.

The incidence of coliforms in condensation in export plants was very low, with only one sample testing positive. This sample was collected from the underside of an evaporator drip tray. No *E. coli* were detected in any of the samples.

Table 1: Microbiological analysis of condensation collected from export registered plants

Plant Code	Chiller Code	No of Samples	Coliforms		*E. coli*	
			Positives	Count/mL	Positives	Count/mL
1	A	4	1	31	nd	nd
	B	4	0	nd	nd	nd
	C	4	0	nd	nd	nd
	D	3	0	nd	nd	nd
	E	2	0	nd	nd	nd
	F	4	0	nd	nd	nd
4	A	1	0	nd	nd	nd
	B	1	0	nd	nd	nd

* nd = not detected (limit of detection = 1 CFU/mL)

Table 2: Results of microbiological analysis of condensation collected from Domestic Plants

Plant Code	Chiller Code	No. of Samples	Coliforms		*E. coli*	
			Positives	Count/mL	Positives	Count/mL
2	A	1	1	95	nd	nd
	B	2	2	188	nd	nd
	C	1	1	106	nd	nd
3	A	15	nd	nd	nd	nd
	B	7	nd	nd	nd	nd
	C	3	nd	nd	nd	nd

* nd = not detected (limit of detection = 1 CFU/mL)

For Plant 2 coliforms were detected in all four samples of condensation collected from ceilings, rails and door jambs. The overall condition of the chillers in this plant was poor from the aspects of quantities of condensation and cleanliness of surfaces. No *E. coli* were detected in any of the samples.

No *E. coli* or other coliforms were detected in any of the samples of condensation from Plant 3.

This investigation focussed on the incidence of coliforms and *E. coli* and the results indicated that in a well-maintained plant they should not be of concern. However this does not mean that other organism of food safety concern such as *Listeria* will not be present in condensation. During an American Meat Institute survey in 1987, *Listeria monocytogenes* was isolated from condensation in 17% of 41 meat processing plants in the U.S.A.

Evaporator Cleaning

Table 3: Results of microbiological analysis of swabs from chiller evaporator fins

Plant	Chiller	(CFU/cm^2)		
		TVC	Coliforms	*E. coli*
1	A	>1000	*n.d.	n.d.
	B	>1000	n.d.	n.d.
	C	-#	n.d.	n.d.
2	A	>1000	n.d.	n.d.
	B	>1000	n.d.	n.d.
	C	>1000	n.d.	n.d.
	D	>1000	n.d.	n.d
3	A	>1000	n.d.	n.d.
	B	2,000	n.d.	n.d.

* nd = not detected (limit of detection = 0.4 CFU/cm^2)
# - = not analysed

The results of swab sampling of the fin surfaces of the evaporators in three abattoirs are presented in Table 3. These evaporators had not been subjected to any special cleaning regime. The level of bacteria present on the fins tested was high regardless of the overall condition of the chillers and the frequency of general chiller cleandown.

Any dirt that is deposited on the evaporator fins tends to accumulate on the leading, or air-on edges of the fins. Due to the location of the fans, the fins of an induced draft cooler (IDC) are much easier to clean than those of a forced draft cooler (FDC).

An IDC in one chiller was swabbed for microbiological analysis before and after cleaning. The air in the chiller was also sampled before and after the evaporator was cleaned. The results are presented in Table 4.

Table 4: Effect of cleaning on microbiological status of evaporator fin surface and chiller air

	TVC on Fin Surface (CFU/cm^2)	TVC of Air Sample (CFU/min)
Before Cleaning	2,000	5
After Cleaning	10.5	4

The cleaning had an effect on the total aerobic count on the evaporator fins but there was little change in the number of organisms collected from the air during the limited amount of sampling that was possible.

CONCLUSIONS

1. *E. coli* were not detected in any of the samples of condensation from export or domestic plants.

2. There was a 4% incidence (1 positive) of coliforms in samples of condensation from export plants.

3. There was a 14% incidence (4 positive) of coliforms in samples of condensation from domestic plants.

4. Most of the chillers from which samples positive to coliforms were collected were from one plant. These could have benefited from a thorough clean. Subsequent to the trial, the plant management instituted a regular cleaning program for the chillers.

Where chillers were kept in a clean and hygienic manner there was no evidence of coliforms or *E. coli* present in the condensation. Coliforms were only detected in significant numbers in chillers where visual inspection revealed the need for thorough cleaning.

Manual cleaning of evaporators and fins reduced the bacterial load present, although it appeared to have little effect on the overall level of airborne bacteria measured using an air sampler. Due to the limited scope of this project the long term effect of cleaning on the airborne bacterial load could not be assessed. To accurately determine the required frequency of cleaning of evaporators and fins further work over an extended period of time may be warranted.

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