

WG3

P9: Meta-analysis of the efficacy of cattle hide interventions to reduce microbiological contamination in beef



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WG3 Introduction & Methodology

- Interventions at abattoir level to control microbiological hazards are an essential part of meat safety assurance systems
- Cattle hide interventions can be seen as a 'proactive' method to deal with sources of beef carcass contamination.
- A systematic review has already performed to identify literature investigating the efficacy of processing interventions to control microbiological contamination in beef was performed.
- Risk of bias performed to see which studies are suitable for meta-analysis.
- Meta-analysis was performed when an intervention group had more than three trials with a low risk of bias.
- A mixed-effects model was used to create pooled summary statistics and then presented as Forest plots. Tests for heterogeneity of study groups were additionally performed.

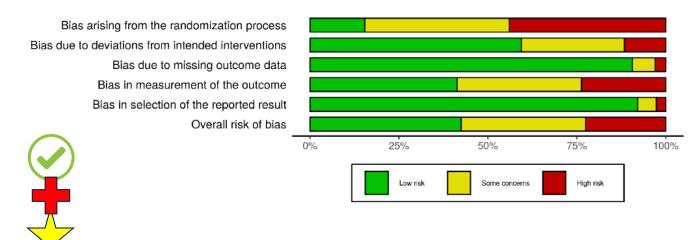


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WG3 Results - Risk of Bias

- 266 relevant studies were identified.
- 42.5% (113) were of low risk of bias and available for meta-analysis.
- Interventions that had extractable data were:
 - Hide cleanliness assessment 4 papers
 - On hide interventions (i.e. hide water washes, shellac) 7 papers
- Insufficient number of studies to assess:
 - Hide clipping
 - Bacteriophage treatment
 - Chemical washes
- Meta-analysis grade:
 - Significant positive effect
 - Non-significant positive effect
 - Significantly homogenous studies

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WG3 Results – Hide cleanliness assessments

Using hide cleanliness scores led to:



- Aerobic colony count (ACC) reduction:
 - 0.90 log CFU/cm², 95%CI 0.54-1.26, *I*²=88.4%
 - 4 papers, 20 trials



- Enterobacteriaceae counts (EBC) reduction:
 - 0.71 log CFU/cm², 95%CI 0.36-1.05, *I*²=88.4%
 - 2 papers, 10 trials





- E.coli reduction:
 - 0.75 log CFU/cm², 95%CI 0.65-0.85, *I*²=0%
 - 1 paper, 6 trials

Study	Intervention	Description	Mean Difference	MD	95%-CI	Weight
Serraino (2012) Serraino (2012) Serraino (2012) Serraino (2012) Serraino (2012) Serraino (2012) Heterogeneity: l ² =	UK scoring system 0%, t ² =0.001, p=0.98	Clean hide cat. 1 vs Dirty hide cat 3 Clean hide cat. 1 vs Dirty hide cat 5 Clean hide cat. 2 vs Dirty hide cat 3 Clean hide cat. 2 vs Dirty hide cat 5 Clean hide cat. 1 vs Dirty hide cat 4 Clean hide cat. 2 vs Dirty hide cat 4	1 05 0 05 1	-0.80 -0.80 -0.80 -0.80 -0.60 -0.60	[-1.36; -0.24] [-1.20; -0.40] [-1.36; -0.24] [-1.20; -0.40] [-1.16; -0.04] [-0.85; -0.65]	12.9% 24.1% 12.9% 24.1% 12.9% 12.9%

Study	Intervention	Description	Mean Difference	MD	95%-CI	Weigh
Serraino (2012)	UK scoring system	Clean hide cat. 1 vs Dirty hide cat 5		-2.80	[-3.35; -2.25]	5.0%
Serraino (2012)	UK scoring system	Clean hide cat. 2 vs Dirty hide cat 5		-2.20	[-2.78; -1.62]	5.0%
Serraino (2012)	UK scoring system	Clean hide cat. 1 vs Dirty hide cat 4	-	-2.10	[-2.50; -1.70]	5.4%
Serraino (2012)	UK scoring system	Clean hide cat. 1 vs Dirty hide cat 3	-	-1.50	[-2.32; -0.68]	4.3%
Serraino (2012)	UK scoring system	Clean hide cat. 2 vs Dirty hide cat 4	-	-1.50	[-1.94; -1.06]	5.3%
Blagojevic (2012)	UK scoring system	Clean hide cat. 1 vs Dirty hide cat 4		-1.13	[-1.65; -0.61]	5.1%
Hauge (2012)	Norwegian scoring system	Clean hide cat. 0 vs Dirty hide cat 1	-	-0.90	[-1.30; -0.50]	5.4%
Serraino (2012)	UK scoring system	Clean hide cat. 2 vs Dirty hide cat 3		-0.90	[-1.74: -0.06]	4.3%
Blagojevic (2012)	UK scoring system	Clean hide cat. 2 vs Dirty hide cat 4	-	-0.76	[-1.29; -0.23]	5.1%
McEvoy (2000)	Irish scoring system	Clean hide cat. 2 vs Dirty hide cat 3	- I	-0.62	[-1.06; -0.18]	5.3%
McEvoy (2000)	Irish scoring system	Clean hide cat. 2 vs Dirty hide cat 5	-	-0.54	[-1.04; -0.04]	5.2%
McEvov (2000)	Irish scoring system	Clean hide cat. 2 vs Dirty hide cat 5	-	-0.53	[-0.96: -0.10]	5.3%
McEvoy (2000)	Irish scoring system	Clean hide cat. 2 vs Dirty hide cat 5		-0.53	[-1.13; 0.07]	4.9%
McEvoy (2000)	Irish scoring system	Clean hide cat. 2 vs Dirty hide cat 3		-0.49	[-1.09; 0.11]	4.9%
Hauge (2012)	Norwegian scoring system	Clean hide cat. 0 vs Dirty hide cat 2		-0.48	[-1.16; 0.20]	4.7%
McEvoy (2000)	Irish scoring system	Clean hide cat. 2 vs Dirty hide cat 2		-0.34	[-0.87; 0.19]	5.1%
Blagojevic (2012)	UK scoring system	Clean hide cat. 1 vs Dirty hide cat 3	-	-0.34	[-0.73; 0.05]	5.4%
McEvov (2000)	Irish scoring system	Clean hide cat. 2 vs Dirty hide cat 5		-0.15	[-0.93; 0.63]	4.5%
McEvoy (2000)	Irish scoring system	Clean hide cat. 2 vs Dirty hide cat 3		-0.13	[-0.81; 0.77]	4.4%
Blagojevic (2012)	UK scoring system	Clean hide cat. 2 vs Dirty hide cat 3	- I	0.02	[-0.38; 0.44]	5.4%
Diagojević (2012)	or scoring system	Clearriide cat. 2 vs Diity fiide cat 3	T	0.03	[-0.30, 0.44]	3.470
Heterogeneity: I2=8	8.4%, t ² =0.515, p<0.0001		⇒	-0.90	[-1.26; -0.54]	100.0%
,			T T T	7 -0.90	[-1.20, -0.54]	100.076
			-3 -2 -1 0 1 2	3		
			-3 -2 -1 0 1 2	3		

Study	Intervention	Description	Mean Difference	MD	95%-CI	Weight
Serraino (2012)	UK scoring system	Clean hide cat. 1 vs Dirty hide cat 3		-1.50	[-2.61; -0.39]	5.1%
Serraino (2012)	UK scoring system	Clean hide cat. 2 vs Dirty hide cat 3		-1.50	[-2.61; -0.39]	5.1%
Serraino (2012)	UK scoring system	Clean hide cat. 1 vs Dirty hide cat 5	· ·	-1.10	[-1.56; -0.64]	11.1%
Serraino (2012)	UK scoring system	Clean hide cat. 2 vs Dirty hide cat 5	-	-1.10	[-1.56; -0.64]	11.1%
Blagojevic (2012)	UK scoring system	Clean hide cat. 2 vs Dirty hide cat 4		-0.71	[-1.10; -0.32]	11.8%
Serraino (2012)	UK scoring system	Clean hide cat. 1 vs Dirty hide cat 4	- i -	-0.70	[-1.21; -0.19]	10.5%
Serraino (2012)	UK scoring system	Clean hide cat. 2 vs Dirty hide cat 4		-0.70	[-1.21; -0.19]	10.5%
Blagojević (2012)	UK scoring system	Clean hide cat. 1 vs Dirty hide cat 4		-0.68	[-1.17; -0.19]	10.7%
Blagojevic (2012)	UK scoring system	Clean hide cat. 2 vs Dirty hide cat 3	-	-0.05	[-0.36; 0.26]	12.7%
Blagojevic (2012)	UK scoring system	Clean hide cat. 1 vs Dirty hide cat 3		-0.02	[-0.44; 0.40]	11.5%
Heterogeneity: I ² =1	74.0%, t ² =0.175, p<0.0	0001		-0.71	[-1.05; -0.36]	100.0%



WG3 Results - Hide water washes

• Hide water washes may led to reduced pathogen prevalence on hides:



STEC: Relative Risk (RR) 0.85; 95%CI 0.66-1.09, I^2 =85%

4 papers, 6 trials

Study	Intervention	Description	R	isk Ratio	RF	95%-CI	Weight
Arthur (2008) Wang (2014) Wang (2014) Bosilevac (2005b) Bosilevac (2005b) Scanga (2011)	Water spray wash Water spray wash with manual curry comb Water spray wash with manual curry comb Double water spray wash Water spray wash Water spray wash (localised)	Hide wash cabinet 24°C, 15 lb/in² 24°C, 15 lb/in² 24°C, 15 lb/in² 60°C, 10+10s, 700 lb/in², model hide-wash 15°C, 10s, 700 lb/in², model hide-wash 60°C, 3min, 2 atm			0.61 0.65 0.74 0.92 1.04 1.08	[0.51; 1.07] [0.86; 0.98] [0.98; 1.11]	16.8% 12.7% 11.9% 20.5% 20.6% 17.5%
Heterogeneity: 1 ² =85	i% t ² =0.047, p<0.01		-		0.88	[0.66; 1.09]	100.0%
			0.5	1	2		

• Hide water washes may led to a mean reduction of aerobic bacteria on hides:



• ACC: 0.60 log CFU/100cm², 95%CI -0.02-1.26, *I*²=99.7%

3 papers, 4 trials

Study	Intervention	Description		Mean	Differe	ence		MD	95%-CI	Weight
Bosilevac (2005b) Wang (2014) Bosilevac (2005b) Scanga (2011)	Double water spray wash Water spray wash with manual curry comb Water spray wash Water spray wash (localised)	60°C, 10+10s, 700 lb/in², model hide-wash 24°C, 15 lb/in² 15°C, 10s, 700 lb/in², model hide-wash 60°C, 3min, 2atm	-	-	1			-1.00 -0.80 -0.50 -0.11	[-1.11; -0.89] [-0.85; -0.75] [-0.61; -0.39] [-0.11; -0.11]	24.8% 25.2% 24.8% 25.3%
Heterogeneity: I ² =99	0.7% t ² =0.148, p<0.0001		-1	-0.5	0	0.5	¬ 1	-0.60	[-1.22; 0.02]	100.0%

• How useful are hide water washes as a standalone intervention?



WG3 Results – Microbial immobilization treatments

- Shellac microbial immobilisation treatment of cattle hides may lead to:
 - ACC reduction:



- 1.07 log CFU/cm², 95%CI -0.29-2.43, *I*²=85.7%
- 2 papers, 3 trials

Study	Intervention	Description		Mean	Differe	nce		MD	95%-CI	Weight
Antic (2011) Antic (2018) Antic (2018)	Shellac (23%) spray in ethanol hide coating Aqueous shellac (35%) hide spray coating Aqueous shellac (35%) hide spray coating	20°C, 8min 20°C, 3min 20°C, 3min	-	— <u> </u>	-			-1.70 -0.96 -0.61	[-2.17; -1.23] [-1.27; -0.65] [-0.93; -0.29]	31.0% 34.6% 34.4%
Heterogeneity	$(t)^2 = 85.7\%, t^2 = 0.254, p < 0.001$			-	+	1	_	-1.07	[-2.43; 0.29]	100.0%
			-2	-1	0	1	2			

EBC reduction:



- 0.59 log CFU/cm², 95%CI -1.05-2.22, *I*²=85.1%
- 2 papers, 3 trials

Study	Intervention	Description	Mean D	ifference	MD	95%-CI	Weight
Antic (2011) Antic (2018) Antic (2018)	Shellac (23%) spray in ethanol hide coating Aqueous shellac (35%) hide spray coating Aqueous shellac (35%) hide spray coating	20°C, 8min 20°C, 3min 20°C, 3min		-	-1.40 -0.33 -0.14	[-1.99; -0.81] [-0.52; -0.14] [-0.50; 0.22]	29.9% 36.1% 34.0%
Heterogeneity	: I ² =85.1%, t ² =0.377, p=0.001				-0.59	[-2.22; 1.05]	100.0%
			-1	0 1			

Show the potential for reduction, but need more research...



WG3 Results - Treatment comparison

- 6 controlled trials under commercial abattoir conditions compared. Investigating:
 - Shellac spray hide coating
 - Cetylpyridinium chloride spray wash
 - Sanitizer spray wash
 - Sodium hydroxide spray wash
- Together these studies showed:
 - ACC reduction:



- 1.09 log CFU/cm², 95%CI 0.65-1.53, *I*²=100%
- 4 papers, 6 trials
- EBC reduction:



- 0.81 log CFU/cm², 95%CI 0.28-1.35, *I*²=93.0%
- 4 papers, 6 trials

Study	Intervention	Description	Mean Difference	MD	95%-CI	Weight
Antic (2011) Bosilevac (2004) Antic (2011) Antic (2018) Bosilevac (2005a) Antic (2018) Heterogeneity: I ² =10	Shellac (23%) spray in ethanol hide coating Cetylpyndinium chloride 1% spray wash Proprietary OAC Sanitiser wash with vacuum Aqueous shellac (35%) hide spray coating Sodium hydroxide 1.5% spray wash/chlorine rinse with vacuum Aqueous shellac (35%) hide spray coating 0.00%, t²=0.14, p<0.0001	20°C, 8min 20°C, 3+1min, 500 lb/in² 50°C, 6min 20°C, 3min 65°C, 700 lb/in² 20°C, 3min	2 1 0 1 2	-1.70 -1.50 -1.00 -0.96 -0.80 -0.61 -1.09	[-2.17; -1.23] [-1.50; -1.50] [-1.61; -0.39] [-1.27; -0.65] [-0.80; -0.80] [-0.93; -0.29] [-1.53; -0.65]	14.3% 19.9% 12.0% 17.0% 19.9% 16.8% 100.0%

Study	Intervention	Description	Mean Difference	MD	95%-CI	Weight
Antic (2011) Antic (2011) Bosilevac (2004) Bosilevac (2005a) Antic (2018) Antic (2018)	Shellac (23%) spray in ethanol hide coating Proprietary QAC santiser wash with vacuum Cetylpyridinium chloride 1% spray wash Sodium hydroxide 1.5% spray wash/chlorine rinse with vacuum Aqueous shellac (35%) hide spray coating Aqueous shellac (35%) hide spray coating	20°C, 8min 50°C, 6min 20°C, 3+1min, 500 lb/in131 65°C, 700 lb/in² 20°C, 3min 20°C, 3min	-	-1.40 -1.30 -1.10 -0.80 -0.33 -0.14	[-1.99; -0.81] [-1.85; -0.75] [-1.20; -1.00] [-1.00; -0.60] [-0.52; -0.14] [-0.50; 0.22]	13.6% 14.2% 18.9% 18.3% 18.3% 16.6%
Heterogeneity: I ² =9	3.0%, t ² =0.22, p<0.0001		-1 0 1	-0.81	[-1.35; -0.28]	100.0%



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WG3 Discussion & Conclusions

Cattle hide interventions can control microbial contamination on beef

carcasses

- Especially hide cleanliness assessments
- However:
 - Low number of studies with low risk of bias
 - Not all studies had extractable data
 - High heterogeneity of studies
- Only one MA shown here was homogenous with a positive effect.
- Recommendations:
 - More research is needed
 - Methodologies and data recording needs to be harmonised



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