CHAPTER IV

RESULTS

4.1 Total Viable Count (TVC) and *Enterobacteriaceae* count

Table 4 illustrates the overall mean TVC and *Enterobacteriaceae* count values for all samples as well as total mean values for environmental samples and carcass swabs.

The total mean value for TVC for all swabs collected in both facilities was 4.58±1.25 log cfu/cm^2 (n=180). For environmental samples on the whole, the total mean was 4.73±1.29 log cfu/cm^2 (n=140) while a value of 4.06±0.95 log cfu/cm^2 (n=40) was recorded for all carcass samples (Table 4).

Table 4 Total Viable Counts and *Enterobacteriaceae* counts in environmental and carcass swabs

	Samples	**n**	**Mean±SD (log cfu/cm^2)**
Total Viable Count	Environmental samples	140	4.73±1.29
	Carcass samples	40	4.06±0.95
	All Samples	180	4.58±1.25
Enterobacteriaceae Count	Environmental samples	140	2.01±1.42
	Carcass Samples	40	2.32±1.48
	All Samples	180	2.08±1.44

The total mean *Enterobacteriaceae* count for the all swabs obtained was 2.08±1.44 log cfu/cm^2 (n=180). Environmental samples and carcass samples had means of 2.01±1.42 log cfu/cm^2 (n=140) and 2.32±1.48 log cfu/cm^2 (n=40), respectively (Table 4).

Table 5 compares the mean values for TVC and *Enterobacteriaceae* counts in environmental as well as carcass swabs in both slaughterhouses. Comparing the two classifications, the mean TVC of environmental samples in the unaccredited slaughterhouse was 4.51±1.06 log cfu/cm^2 (n=70) and that from the accredited slaughterhouse was 4.95±0.63 log cfu/cm^2 (n=70). This difference was found to be statistically significant (p value = 0.0434). Meanwhile in carcasses, TVC means were 3.99±0.91 log cfu/cm^2 (n=20) and 4.13±1.01 log cfu/cm^2 (n=20) in the former and latter facilities, respectively (Table 5).

Table 5 Mean values for TVC and *Enterobacteriaceae* count in environmental sites and carcasses from both unaccredited and accredited slaughterhouses

		n	**Unaccredited (log cfu/cm^2)**	**n**	**Accredited (log cfu/cm^2)**	**p-value**
TVC	Environmental samples	70	4.51±1.06	70	4.95±0.63	0.0434*
	Carcass samples	20	3.99±0.91	20	4.13±1.01	0.6497
EC	Environmental samples	70	2.03±0.78	70	1.99±0.64	0.851
	Carcass samples	20	2.12±1.02	20	2.53±1.84	0.3806

**statistically significant with p-value <0.05*

The mean value for *Enterobacteriaceae* was of 2.03±0.78 log cfu/cm^2 (n=70) for all environmental samples from the unaccredited abattoir, slightly higher than the accredited facility at 1.99±0.64 log cfu/cm^2 (n=70). For carcasses, counts were 2.12±1.02 log cfu/cm^2 (n=20) and 2.53±1.84 log cfu/cm^2 (n=20) in the former and latter facilities.

A comparison of means of the various environmental sites along the slaughter lines of both the unaccredited and accredited facilities is demonstrated in Table 6 for TVC and Table 7 for *Enterobacteriaceae* count.

Table 6 Mean values for TVC in environmental sites and carcasses sampled in unaccredited and accredited slaughterhouses

	Sampling Site	**n**	**Unaccredited (log cfu/cm^2)**	**n**	**Accredited (log cfu/cm^2)**	**p-value**
Carcass contact surfaces along the slaughter line	Scalding Vat	20	2.57±0.87	20	4.22±0.70	0.0002*
	Dehairing Table	20	4.41±1.84	20	5.46±0.38	0.1061
	Eviscerating Table	20	5.64±0.92	20	5.53±0.44	0.7520
	Splitting Knife	20	4.22±1.40	20	4.21±0.85	0.9919
Other environmental sites	Floor	20	5.76±0.71	20	5.20±0.72	0.0956
	Butcher's Knife	20	4.64±1.50	20	5.56±0.40	0.0900
	Workers Hands	20	4.32±1.50	20	4.46±0.88	0.7974
	Carcass	20	3.99±0.91	20	4.13±1.01	0.6497

**statistically significant with p-value <0.05*

In comparing the TVC values of individual environmental sites both facilities, all but one site was shown to be not statistically different. The mean TVC value of the scalding vat in the unaccredited abattoir was 2.57±0.87 log cfu/cm^2 (n=20) was lower than that of the same environmental site in the accredited abattoir at 4.22±0.70 log cfu/cm^2 (n=20). The difference in these values was found to be statistically significant (p value = 0.0002) (Table 6).

Meanwhile, there was no statistically significant difference in the *Enterobacteriaceae* counts of any environmental site between accredited and unaccredited slaughterhouses (Table 7).

Table 7 Mean values for *Enterobacteriaceae* counts in environmental sites and carcasses sampled in unaccredited and accredited slaughterhouses

	Sampling Sites	N	Unaccredited (log cfu/cm^2)	n	Accredited (log cfu/cm^2)	p-value
Carcass contact surfaces along the slaughter line	Scalding Vat	20	1.03±1.38	20	1.22±1.40	0.7603
	Dehairing Table	20	1.60±1.46	20	1.38±1.39	0.7307
	Eviscerating Table	20	1.20±1.09	20	1.49±1.32	0.5882
	Splitting Knife	20	2.68±0.86	20	2.21±1.86	0.4851
Other environmental sites	Floor	20	2.47±1.43	20	2.27±1.36	0.7507
	Butcher's Knife	20	3.11±1.52	20	2.32±0.90	0.1810
	Workers Hands	20	2.15±0.50	20	3.01±1.41	0.0942
	Carcass	20	2.12±1.02	20	2.53±1.84	0.3806

**statistically significant with p-value <0.05*

4.2 Water samples: Most Probable Number (MPN) of *E. coli* and coliforms

The number of coliforms and *E. coli* detected in water samples from the unaccredited abattoir ranged from 4.51 to >2300 MPN/ml and 2.71 to 2300 MPN/ml respectively (Figure 2).

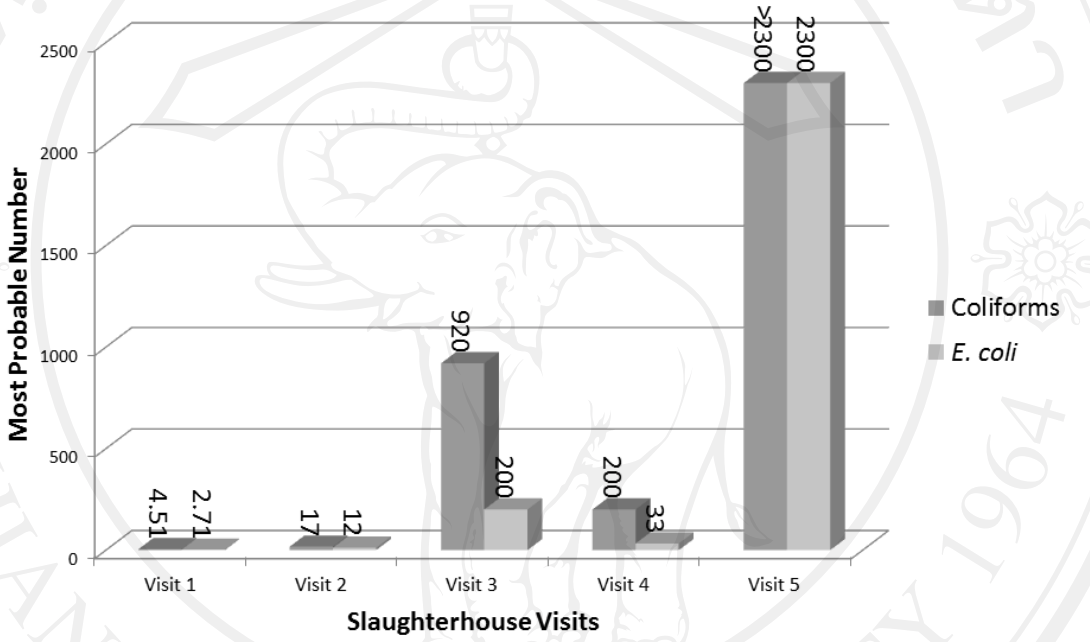

Figure 2 Most Probable Number (MPN) of coliforms and *E. coli* detected in water samples from an unaccredited slaughterhouse in NCR

For the accredited facility, the range of coliforms detected was <0.90 to 16.67 MPN/ml while *E. coli* levels were from <0.90 to 11.61 MPN/ml (Figure 3).

Note: Figures 2 and 3 are not scaled uniformly to demonstrate and emphasize the range of values obtained for each facility.

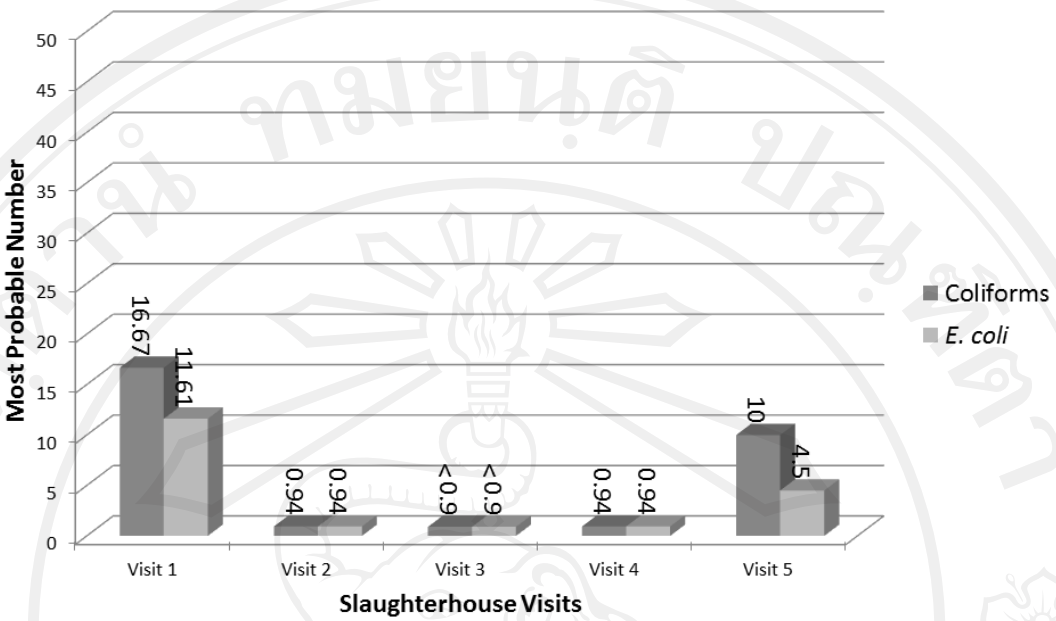

Figure 3 Most Probable Number (MPN) of coliforms and *E. coli* detected in water samples from an accredited slaughterhouse in NCR

4.3 Detection of *Salmonella*

The prevalence of *Salmonella* for all environmental and carcass samples in this study was 15.6% (95% CL: 10.6 – 21.5), with 28 positive out of a total of 180 samples. For environmental samples, 25 out of the total of 140 samples tested positive yielding a prevalence of 17.9% (95% CL: 12.1 - 25.1). On the other hand, *Salmonella* prevalence for all carcass samples was recorded at 7.5% (95% CL: 2.1 – 19.4), where 3 out of 40 carcass samples tested positive (Table 8).

Table 8 *Salmonella* in environmental and carcass samples

	Positive samples	**N**	**Prevalence (%)**	**95% CL**
Environmental samples	25	140	17.9	12.1 - 25.1
Carcass samples	3	40	7.5	2.1 - 19.4
Total	28	180	15.6	10.6 - 21.5

In comparing between the two classifications of slaughterhouses, the study found that *Salmonella* prevalence in unaccredited slaughterhouses was 20% (95% CL: 12.4-29.3) with 18 positive samples out of 90. In accredited slaughterhouses, the prevalence was 11.1% (95% CL: 5.7 – 19.2) with 10 samples out of 90 testing positive (Table 9).

This study also compared the prevalence of *Salmonella* in environmental samples as well as in carcasses between both slaughterhouse types. Table 9 shows the prevalence of *Salmonella* in environmental samples between unaccredited and accredited facilities. Prevalence was recorded unaccredited slaughterhouses at 21.4% (95% CL: 13.1 – 32.6) and at 14.3% (95% CL: 7.3 – 24.7) in accredited slaughterhouses.

Table 9 *Salmonella* in environmental and carcass samples in unaccredited and accredited slaughterhouses

		Positive samples	n	Prevalence	95% CL
Unaccredited Slaughterhouses	Environmental samples	15	70	21.4	13.1 - 32.6
	Carcass samples	3	20	15	4.2 - 36.9
	Total	18	90	20	12.4 - 29.3
Accredited Slaughterhouses	Environmental samples	10	70	14.3	7.3 - 24.7
	Carcass samples	0	20	0	0 - 16
	Total	10	90	11.1	5.7 - 19.2

Prevalence of *Salmonella* in carcasses was recorded at 15% (95% CL: 4.2 - 36.9) in unaccredited slaughterhouses where 3 out of 20 samples tested positive. Meanwhile, none of the 20 carcass samples collected from accredited slaughterhouses where positive for *Salmonella* (Table 9).

Figure 4 demonstrates a breakdown of the percentages of positive environmental samples in this study, *Salmonella* was detected in the following descending order: slaughterhouse floors (28%), butcher's knives (28%), worker's hands (20%), dehairing table (12%), splitting knives (8%) and eviscerating tables (4%).

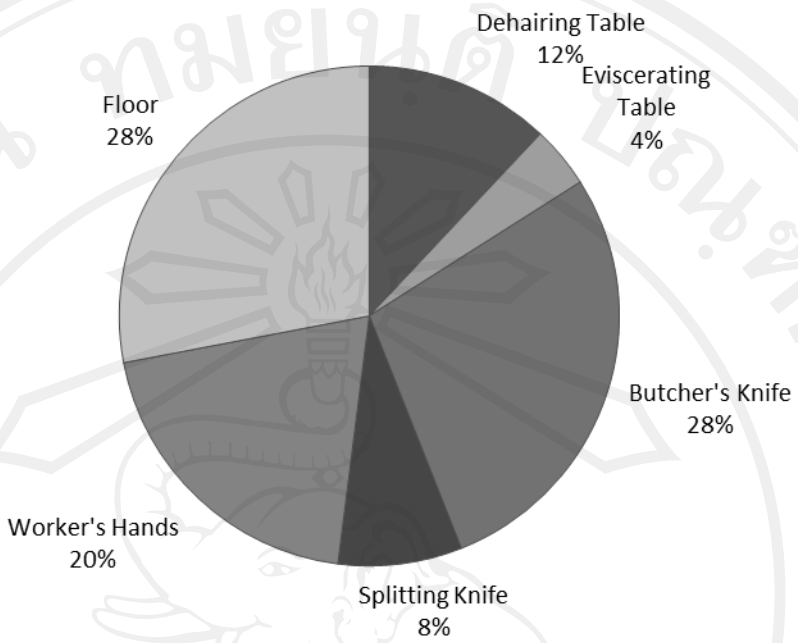

Figure 4 *Salmonella* positive environmental sites by percentage

For the accredited slaughterhouse, samples tested positive for *Salmonella* in the slaughterhouse floor (60%), worker's hands (20%), butcher's knives (10%) and eviscerating tables (10%) as seen in Figure 5.

Meanwhile in the unaccredited facility, environmental sites that tested positive were the following: butcher's knives (40%) followed by worker's hands (20%), dehairing tables (20%), splitting knives (13%) and slaughterhouse floors (7%) (Figure 6).

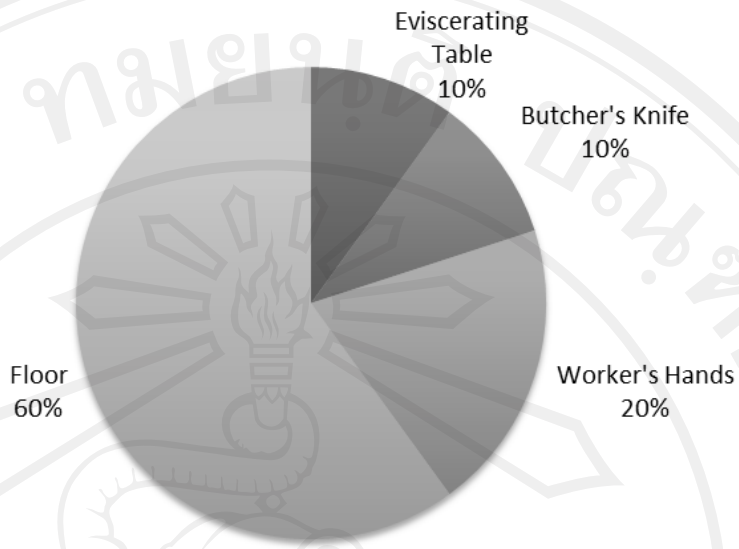

Figure 5 Percentage of *Salmonella* positive environmental samples in accredited slaughterhouses

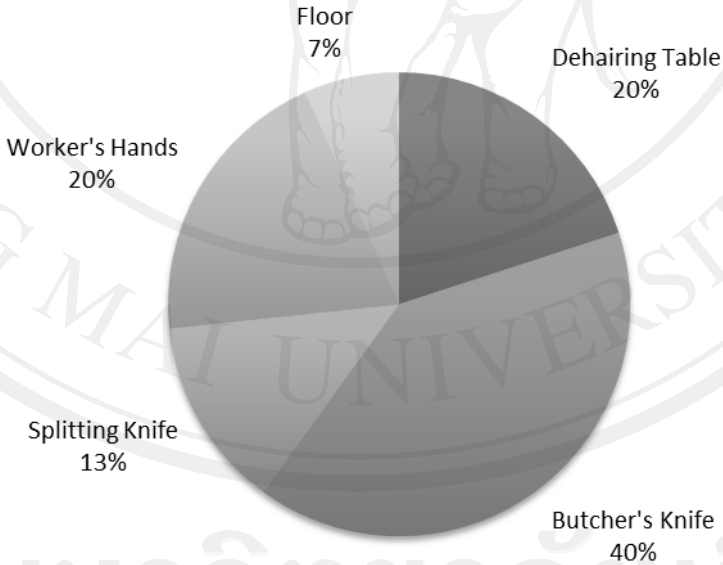

Figure 6 Percentage of *Salmonella* positive environmental samples in unaccredited slaughterhouses

Table 10 Occurrence of *Salmonella* in unaccredited and accredited slaughterhouses

	n = 15	**Unaccredited Slaughterhouse**	**n = 10**	**Accredited Slaughterhouse**
Scalding Vat	0	0%	0	0%
Dehairing Table	3	20%	0	0%
Eviscerating Table	0	0%	1	10%
Floor	1	7%	6	60%
Butcher's Knife	6	40%	1	10%
Splitting Knife	2	13%	0	0%
Worker's Hands	3	20%	2	20%

Salmonella serotypes obtained

According to results of serotyping of isolates, the following *Salmonella* serotypes were detected (in descending order of percentage) in environmental and carcass swabs: *S.* enterica subsp. enterica ser. 4,5,12:i: (21%), *S.* Rissen (18%), *S.* Weltevreden (18%), *S.* enterica subsp. enterica ser. 16:lv: (11%), *S.* Kentucky (11%), *S.* Newport (11%), *S.* Derby (7%) and *S.* Typhimurium (3%).

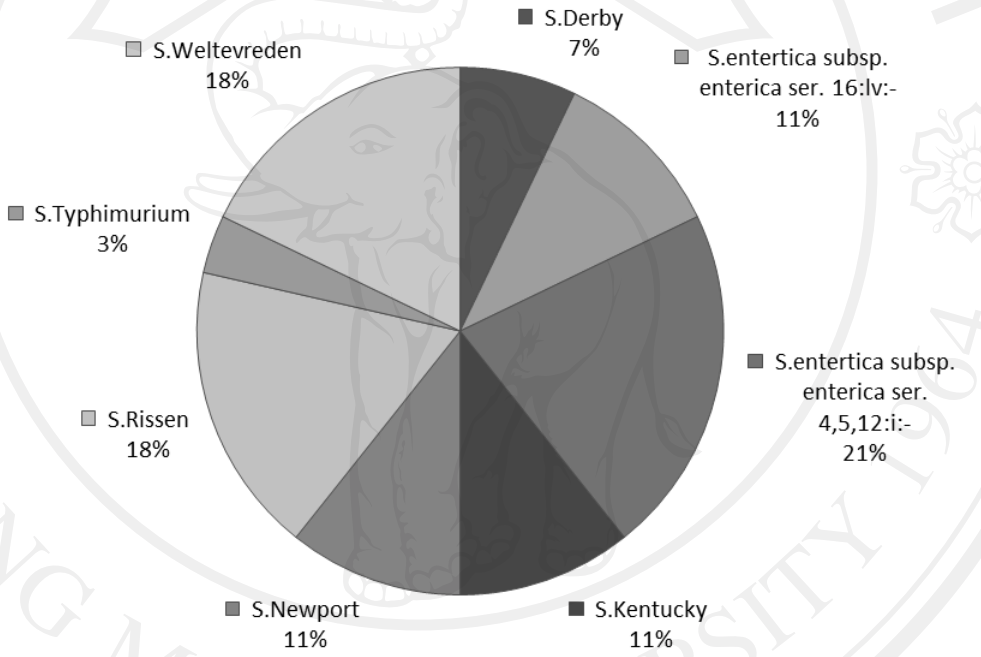

Figure 7 *Salmonella* serotypes of isolates from environmental and carcass samples in percent

4.4 Profile of slaughterhouses involved in the study

The slaughter lines of both the accredited and unaccredited establishments involved in this study conform to the tiered or terraced design of small and medium scale slaughterhouses in APHCA member countries as described by Heinz in 2008. Each, facility, however, has some design modifications and peculiar characteristics in terms of infrastructure, equipment and slaughter habits. The following table shows a detailed comparison of both establishments:

Table 11 Comparison of accredited and unaccredited slaughterhouse facilities and operations

	Unaccredited	**Accredited**
I. Demographics		
A. Supervising Authority	Local Government Units	NMIS
B. Ownership	Privately owned	Privately owned
C. Daily slaughter	50 animals (70 - 80 on weekends)	200 animals (250 - 300 on weekends)
D. Slaughter schedule	1AM to 5AM; often not strictly followed since slaughtering is done anytime as need arises	11PM to 7AM
II. Building and Infrastructure		
A. Location	Prone to flooding	Not prone to flooding
B. Facility Layout		
1. Structure and design	Two-tiered system	Three-tiered system
2. Clean and dirty areas	Not separate	Separate
3. Live animal receiving and meat loading areas	Separate	Separate
4. Process flow	One way	One way
C. Floor Construction		
1. Floor material	Concrete	Concrete
2. Condition	Poor maintenance	Good
3. Floor orientation	Not sloped; water accumulates in some areas	Sloped to allow drainage

D. Walls, Ceiling and Roofs		
1. Material	Concrete	Tiled
2. Condition	Poor maintenance	Good
E. Drainage	Flows from dirty to clean area	Flows from dirty to clean area
F. Water Supply and Management		
1. Source	Public utility	Deep well
2. Supply	Adequate for slaughter process and cleaning	Adequate for slaughter process and cleaning
3. Storage	Collected in an open tub in the slaughter area	Collected in a water tank separate from slaughter area
4. Potability	Tested annually	Tested bi-annually
III. Facilities along the Slaughterline		
A. Lairage		
1. Material of floor	Concrete	Concrete
2. Washing of animals prior to stunning	Not done	Animals are sprayed with water
B. Stunning and Bleeding		
1. Bleeding	Done at stunning area	Done at stunning area
2. Duration	Less than 1 minute	2 minutes average
3. Sticking knife	Same butcher's knife used for sticking, evisceration and dehairing; only occasionally wiped or washed after each use	Same butcher's knife used for sticking, evisceration and dehairing; only occasionally wiped or washed after each use
C. Scalding and Dehairing		
1. Material of scalding vat	Steel	Stainless steel
2. Monitoring of water temperature	Not performed	Not performed
3. Replacement of water	Augmented during slaughter	Augmented during slaughter
4. Cleaning and maintenance of scalding vat	No regular schedule for cleaning; often pre-heated during time of visit	Water is drained and scalding vat is cleaned after each slaughter period
5. Dehairing area	Single table for dehairing, evisceration and carcass splitting	Dehairing table
6. Dehairing knife	Same butcher's knife used for sticking, evisceration and dehairing; wiped or washed every after carcass	Same butcher's knife used for sticking, evisceration and dehairing; wiped or washed every after carcass

D. Evisceration		
1. Evisceration area	Single table for dehairing, evisceration and carcass splitting	Done at separate eviscerating table
2. Eviscerating knife	Same butcher's knife used for sticking, evisceration and dehairing; wiped or washed every after carcass	Same butcher's knife used for sticking, evisceration and dehairing; wiped or washed every after carcass
E. Carcass Splitting	Single table for dehairing, evisceration and carcass splitting	Done at the eviscerating table
1. Carcass splitting area	Single table for dehairing, evisceration and carcass splitting	Done at the eviscerating table
2. Splitting knife	Cleaver; not regularly cleaned	Cleaver; occasionally wiped or washed after each use
3. Final wash	Water poured from tub in slaughterline	Water sprayed using hoses
IV. Cleaning and Disinfection		
1. Cleaning schedule	Daily cleaning schedule	Daily cleaning schedule; general cleaning using power spray during long holidays
2. Disinfection schedule	No regular disinfection schedule	Disinfection using chlorine every 2 weeks
3. Cleaning of utensils	Washing of knives daily after every slaughter	Washing of knives daily after every slaughter