CHAPTER 4

Results

4.1 Baseline information of poultry slaughterhouses

Descriptive data collection of eligible slaughterhouses (backyard, n=3; commercial, n=2) was collected before sample collection. In the same type of the slaughterhouse, there were some variables that slaughterhouses shared common characteristics and some were different. Comparison of variables between types of slaughterhouse was shown in table 4.1.

Table 4.1 Baseline information of backyard and commercial slaughterhouses

Variable	Backyard (n=4)	Commercial (n=2)
Average slaughter capacity (head/day)	23 (min=12, max=40)	12,000
Operation time	Early morning, start 4-6 AM (n=3) Afternoon, 1 PM (n=1)	Morning to afternoon (7 AM - 5 PM)
Source of chicken	Small farms and backyard rearing (spent laying hen and native chickens)*	Company's and contract farms (mixed commercial breed)
Stunning method	No	Electrical
Slaughtering method	Neck hanging (n=2) Bleeding (throat cutting) (n=1) Cervical dislocation (n=1)	Bleeding
Low- and High-care area separation	No	Yes

* Native chickens are mainly supplied to backyard slaughterhouses, spent laying hens are occasionally supplied to the slaughterhouses depending on finishing of laying cycle

Table 4.1 Baseline information of backyard and commercial slaughterhouses (continued)

Variable	Backyard (n=4)	Commercial (n=2)
Temperature		
- Processing area	29.3 ºC ± 3.2 ºC (n=2)	33.1 ºC ± 5.6 ºC (n=2)
- Scalding and defeathering (water)	73.4 ºC ± 2.5 ºC (n=4)	63.5 ºC ± 2.1 ºC (n=2)
Water source	Tap water (same source as used in households) (n=2)	Ground water treated with chlorine 0.5 – 1.0 ppm (n=2)
Carcass washing	Bathing and immersion in water - After defeathering (n=2) - After evisceration (n=2)	Inside- and outside-carcass washing after evisceration (n=2)
Chilling	Keep carcasses in cooler box with ice (n=3) No, immediately transport to fresh market (n=1)	Overflow system (n=1) Immersion in water with ice (n=1) [Water temperature in chilling tank 1.1 ± 1.1 ºC, carcass temperature 5.4 ± 1.5 ºC]
Chicken carcass weight	1.0 ± 0.3 kg	1.9 ± 0.4 kg

4.2 Contamination rate of *Campylobacter jejuni*

Contamination rate of *C. jejuni* in poultry carcasses taken from the backyard and commercial slaughterhouses was shown in Table 4.2. Overall, contamination rate of *C. jejuni* in backyard slaughterhouses was 1.6 times significantly higher ($p<0.05$) than the commercial slaughterhouses (90.91% and 56.94%, respectively, Table 4.3). Comparison of contamination rate was done for the same type of sample. Cecal samples acquired from chicken carcasses at slaughtering step showed significant differences ($p<0.05$) of positive samples between backyard and commercial slaughterhouses (91.7% and 33.3%, respectively). At backyard slaughterhouses, *C. jejuni* contaminated chicken carcass at evisceration and final product were not significantly different. However, at commercial

slaughterhouses, contamination rate was significantly decrease at chilling step when compared to evisceration step (50% compared to 77.8%, $p<0.05$). Contamination rate of *C. jejuni* in each slaughterhouse at different steps was shown in Table 4.4.

Table 4.2 Contamination rate of *C. jejuni* by type of slaughterhouse

Type of slaughterhouse	Sampling step	Type of sample	No. of samples	Contamination rate (%)
Backyard (n=4)	Slaughtering	Cecal content	12	11 (91.7)
	Evisceration	Whole carcass rinsing	9	8 (88.9)
	Final product	Whole carcass rinsing	12	11 (91.7)
	Total		33	30 (90.9)
Commercial (n=2)	Slaughtering	Cecal content	18	6 (33.3)
	Evisceration	Whole carcass rinsing	18	14 (77.8)
	Washing	Whole carcass rinsing	18	12 (66.7)
	Chilling (final product)	Whole carcass rinsing	18	9 (50.0)
	Total		72	41 (56.9)

Table 4.3 Comparison of *C. jejuni* contamination rate at different sampling steps

Type of slaughterhouse	Sampling step	No. of samples	Contamination rate (%)	p-value
Backyard VS Commercial	Slaughtering	12 18	11 (91.7) 6 (33.3)	Ref 0.00*
Backyard	Evisceration	9	8 (88.9)	Ref
	Final product	12	11 (91.7)	0.61
Commercial	Evisceration	18	14 (77.8)	Ref
	Washing	18	12 (66.7)	0.19
	Chilling (final product)	18	9 (50.0)	0.01*
Backyard VS Commercial	Total	33 72	30 (90.9) 41 (56.9)	Ref 0.00*

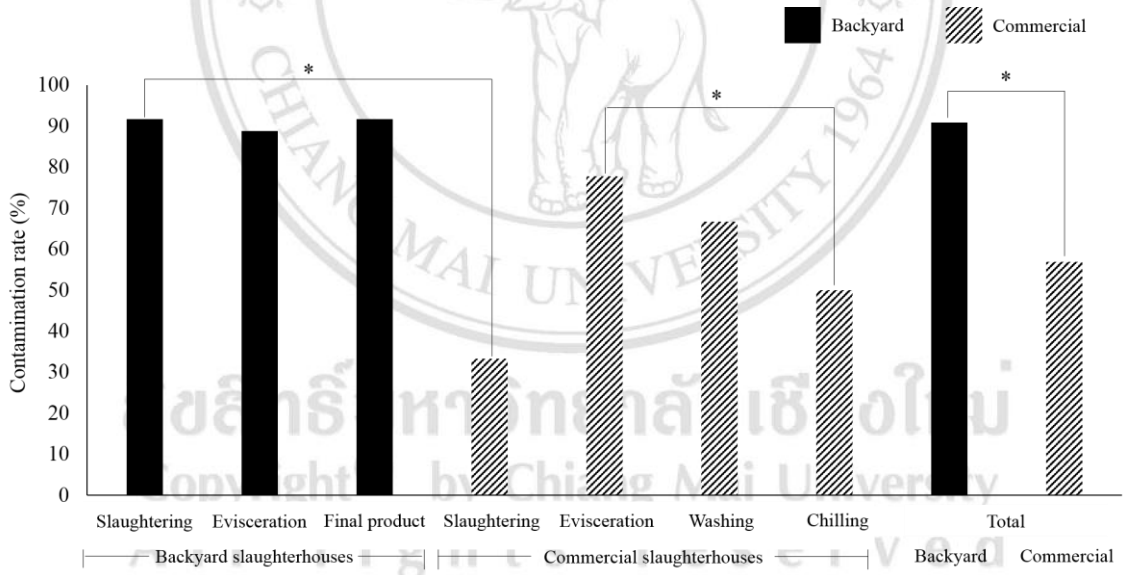
* Significant differences ($p<0.05$) using binomial test

Ref: The value was used as a reference when compared to other value(s) in the interested group.

Table 4.4 Contamination rate of *C. jejuni* in each slaughterhouse at different steps

Slaughterhouse	Contamination rate (%)				
	Slaughtering (n=3)	Evisceration (n=3)	Washing (n=3)	Final product (n=3)	Total
Backyard 1	100	100	-	100	100
Backyard 2	100	-	-	100	100
Backyard 3	66.7	100	-	100	88.9
Backyard 4	100	66.7	-	66.7	77.8
Commercial 1 - 1st visit	100	100	100	100	100
Commercial 1 - 2nd visit	0	66.7	33.3	0	25
Commercial 1 - 3rd visit	66.7	100	33.3	66.7	66.7
Commercial 2 - 1st visit	0	33.3	33.3	0	16.7
Commercial 2 - 2nd visit	33.3	66.7	100	66.7	66.7
Commercial 2 - 3rd visit	0	100	100	66.7	66.7

-: No step existed in that slaughterhouse.



* Significant differences ($p<0.05$) using binomial test

Figure 4.1 Contamination rate of *C. jejuni* at each slaughter step, separated by type

4.3 Level of *Campylobacter jejuni* contamination in backyard and commercial slaughterhouses

Level of *C. jejuni* contamination separated by sampling step was shown in Table 4.5. The level of contamination from backyard slaughterhouses was significantly higher than commercial slaughterhouses by approximately one log CFU/ml of the samples (3.35 compared to 2.41 log CFU/ml, $p<0.05$) (Table 4.6). Comparison of *C. jejuni* counts at the slaughtering step, backyard slaughterhouses showed significantly higher level of contamination, approximately 2 log CFU/g, than commercial slaughterhouses (3.82 compared to 2.00 log CFU/g, $p<0.05$). At different steps in the same type of slaughterhouse, counts of *C. jejuni* was not different between evisceration and final product. At commercial slaughterhouses, after passing the washing and chilling steps, the number of *C. jejuni* gradually decreased nearly the concentration at the slaughtering step but the differences were not statistical significant. Dispersion of raw data for *C. jejuni* counts of all samples collected from backyard and commercial slaughterhouses, separated by slaughter step and type of slaughterhouse, were shown in box plot (Figure 4.2). Level of contamination of carcasses from *C. jejuni*-positive batches was significantly higher ($p<0.05$) than those from negative batches (Table 4.7).

Table 4.5 Level of *C. jejuni* contamination (log CFU/g or log CFU/ml) in samples collected at different steps of slaughter process by type of slaughterhouse

Type of slaughterhouse	Sampling step	No. of samples	*C. jejuni* counts Mean ± SD
Backyard (n=4)	Slaughtering	12	3.82±1.42
	Evisceration	9	3.10±1.07
	Final product	12	3.08±1.08
	Total	33	3.35±1.23
Commercial (n=2)	Slaughtering	18	2.00±2.05
	Evisceration	18	2.97±1.57
	Washing	18	2.64±1.53
	Chilling (final product)	18	2.04±1.67
	Total	72	2.41±1.73

Table 4.6 Comparison of level of *C. jejuni* contamination (log CFU/g or log CFU/ml) at different sampling steps

Type of slaughterhouse	Sampling step	*C. jejuni* counts Mean ± SD	Mean difference	p-value (95% CI)
Backyard VS Commercial	Slaughtering	3.82±1.42	0	Ref
		2.00±2.05	1.82	0.01* (0.42, 3.21)
Backyard	Evisceration	3.10±1.07	0	Ref
	Final product	3.08±1.08	0.02	0.97 (-0.97, 1.01)
Commercial	Evisceration	2.97±1.57	0	Ref
	Washing	2.64±1.53	0.33	0.53 (-0.72, 1.37)
	Chilling (final product)	2.04±1.67	0.92	0.10 (-0.18, 2.02)
Backyard VS Commercial	Total	3.35±1.23	0	Ref
		2.41±1.73	0.94	0.00* (0.35, 1.53)

* Significant differences ($p<0.05$) using independent samples t-test
Ref: The value was used as a reference when compared to other value(s) in the interested group.

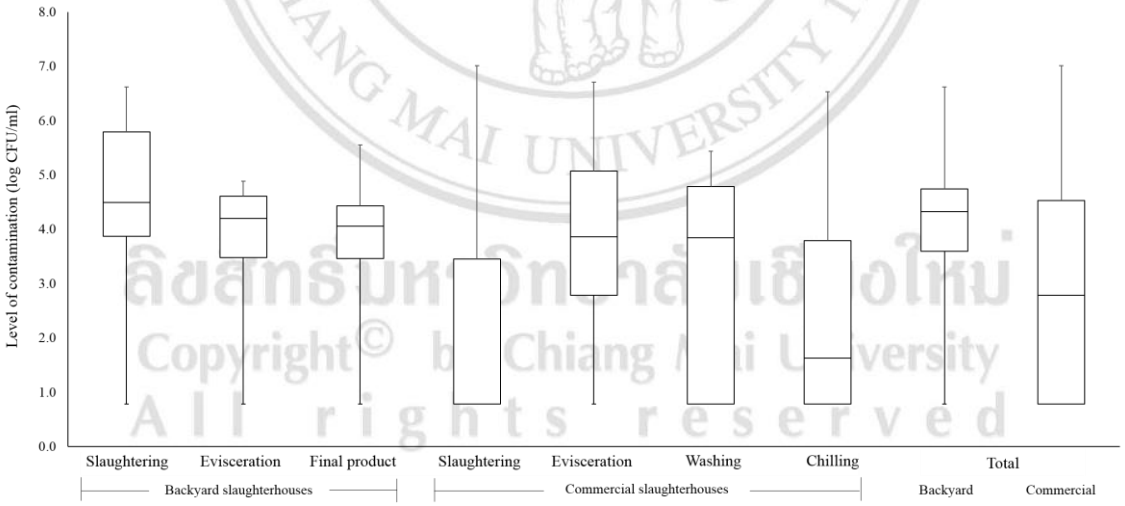


Figure 4.2 Box plot of level of *C. jejuni* contamination in slaughter process

Table 4.7 Comparison of level of *C. jejuni* contamination (log CFU/ml) in carcasses from positive[a] and negative[b] batches

Batch	*C. jejuni* counts Mean ± SD	Mean difference	p-value (95% CI)
Positive	3.27±1.53	0	Ref
Negative	1.63±1.30	1.63	0.00* (1.04, 2.23)

[a] Batches that has contamination rate more than 0 percent at slaughtering step.
[b] Batches that has contamination rate 0 percent at slaughtering step.
* Significant differences ($p<0.05$) using independent samples t-test
Ref: The value was used as a reference when compared to other value(s) in the interested group.

4.4 Workshop on "Poultry Meat Safety…from Slaughterhouse to Consumers"

There were 9 participants from 6 small- and large-scale slaughterhouses attended the workshop who were stakeholders, especially quality control workers, slaughterhouse owners and managers. The focus group discussion was separated into 4 main parts; 1) identification of critical points for contamination along the slaughter line, 2) practical control measures, 3) current barriers or obstacles in the operation of poultry slaughterhouse, and 4) knowledge or support needs from the university.

From the discussion related to the critical points of bacterial contamination along poultry slaughter process, there were several points of concern raised from the participants' opinions, such as;

Contamination at transportation step, uncleaned trucks and crates are more likely to be the mechanical vector of the transmissions between positive and negative batches. At the slaughter line, knives used in slaughtering step without routine cleaning may result to cross-contamination and retained blood inside the carcasses can faster the rotten process. Scalding and defeathering are factors were raised to cause contamination of the agents on carcasses since improper temperature of the water inside the tank and lack of outflow system can lead to accumulation of carcass residues such as blood, feces, and feathers. Moreover, contamination of the carcasses can be easily occurred at evisceration step where manual removing of the intestines may lead to intestinal laceration and contaminate to the carcass surfaces and cross-contaminate to other carcasses.

Carcass washing with untreated water of insufficient pressure may have less ability to wash out the bacteria from the carcasses. In addition, similar to the scalding tank,

chilling tank without overflow or proper temperature may lack the ability to inhibit the growth of the agents. Moreover, temperature at storing areas and during the transportation is the factor that affects the growth of bacteria and decrease the shelf life of the products.

The practical control measures to common foodborne pathogens were raised start from the farm level where only healthy chickens can be transported to slaughterhouses. Ante-mortem inspection should be performed at slaughterhouses when receiving live birds. Routine equipment and hand swab checking at least once a month can help monitor the hygienic status of the slaughterhouses. At stunning and bleeding steps, knives should be cleaned with water temperature higher than 82 ^{o}C. Overflow system is an important factor affecting contamination of the bacteria from the environment and/or from carcass to carcasses. Draining out the used water and replace with treated water to maintain cleanliness of the water in the scalding tank.

Moreover, evisceration step plays a crucial role to generate cross-contamination of intestinal contents to surface of carcasses. In case of abdominal wall opening, the workers should be well-trained to prevent laceration of the intestinal wall that leads to the leakage of intestinal contents and the evisceration fork should be disinfected with water that has temperature more than 82 ^{o}C. Using of personal protective equipment (PPE) at work helps protect cross-contamination from human to carcasses. Other measures included using drinking graded water to wash inside and outside the carcasses with proper water pressure, ice used to cool down the temperature in the chilling tank should be from the sources that have GMP or certified standard from the Thailand Ministry of Public Health and be able to provide quality assurance documents. On the other hand, random sampling of the ice at least once a month is the alternative way to prove the quality of ice. At chilling step, the temperature of the water inside the tank should be less than 1 ^{o}C and the internal temperature of the carcasses should not be higher than 7 ^{o}C. Controlling of the temperature while transportation can help inhibit the growth of bacteria.

Most of control measures were focused on slaughterhouse facilities and good manufacturing practice (GMP) for poultry abattoir (Thailand Ministry of Agriculture and Cooperatives, 2006) based on their background. Participants perceived the benefits of good practices to achieve a standard of meat for consumption. However, investment in those facilities was the obstacle in their perception since changing slaughterhouse

structures and operational facilities, such as slaughter equipment and machinery, require large investments. In addition, increase investment on disinfectants and hiring more workers for controlling cross-contamination in slaughterhouse setting resulting to higher production cost and lower profits. In small-scale slaughterhouses, improvement of processing plant infrastructure and good practices usually require additional investment resulting in higher cost of production that comes to their burden.

Moreover, contamination of the bacteria at market level was also raised as an obstacle of meat safety. Even the contamination rate and level of foodborne pathogens were lower than the infectious limits and safe for consumption, improper practice at market level as a final point in the food production chain to consumers, such as lack of cold chain management, uncleaned chopping block, and so on, can contribute to the contamination and multiplication of the pathogens. Slaughterhouse is not the only one unit to control bacterial contamination, farms and markets also play important roles in safe meat production.

At the end of the discussion, several requests were raised among the participants. The needs included a guideline of good practices in a slaughterhouse, a knowledge guide, such as a booklet or document on how to preserve a product for prolonged shelf-life, suggestions on laboratory testing for routine monitoring of the meat quality as well as a way to efficiently produce safe meat for consumers in terms of having a low level of bacterial contamination and not effecting the cost of operation. The participants have basic knowledge and be aware of poultry meat safety as well as the importance of the pathogenic bacteria that might cause illnesses to human that can be occurred in slaughtering production line.