CHAPTER V

DISCUSSION AND CONCLUSIONS

5.1. Discussion

5.1.1 *Salmonella* prevalence

5.1.1.1 Salmonella prevalence in pig slaughterhouses

In this study, the overall prevalence of *Salmonella* on pig carcasses at slaughterhouse level (34.9%) was lower in comparison to other studies in Hanoi in 2007 (48.9%) (Thai, 2007), in 2006 (95.7%) (Le Bas et al., 2006). A study in Thailand (2010) reported a higher *Salmonella* prevalence on carcass (55.5%) (Sanguankiat et al., 2010), and in Khon Kean by Sithigon (2011) showed slightly higher prevalence on pig carcasses (36.67%). So, the lower prevalence found in our study might be explained by the different time of study when the fact prevalence could reduce. It is also explained by location and capacity of slaughterhouses might have been different as well as the material used when swabbing (using cotton and sponge instead of gauze in this study).

Our findings on *Salmonella* prevalence on pig carcasses was higher when compares with some other findings. Study in Hue-Vietnam in 2009 reported the *Salmonella* prevalence was 15,5% (Takeshi et al., 2009). A review in Northern Thailand by Fries et al. (2006) showed the prevalence of *Salmonella* on carcass was 33.2% (Fries, 2006). *Salmonella* prevalence on pig carcasses reported in the EU in 2008 was 8.3% (EFSA, 2008d), in Belgium in 2003 was 11.2% (Korsak et al., 2003). An investigation in small abattoirs in Wisconsin, USA reported that *Salmonella* on skinned carcasses was 11,7% (Algino et al., 2009).

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Related to *Salmonella* prevalence on workers' hand, with 50% of positive samples, our study finding was higher than a study in Khon Kean, Thailand (2011) (10.71%) (Sithigon. D, 2011).

There might have many factors to be considered such as pig origin or slaughterhouse hygienic condition, time, or country, even sampling or isolation methods. Therefore, lower or higher prevalence might reflect hygienic conditions and management interventions at slaughterhouses observed in this study. When comparing *Salmonella* prevalence on carcasses among the 3 slaughterhouses in this study, highest prevalence was at slaughterhouse C (42.9%) and lowest was at slaughterhouse A (23.8%). However, there was no significant difference (p=0.403, Chi-square test), which can be explained by the pressure of contamination from pigs as well as from the slaughter process. Three slaughterhouses had limited separate areas for the particular slaughtering stages. Carcasses after evisceration are lying on the ground floor with many manipulations by the workers. Moreover, through observation, we recognized that all of 3 slaughterhouses have the habit of wiping carcasses, workers' hands or knives by using cloth (for more than one carcasses), which might be not free of *Salmonella* and may lead to cross-contamination.

In addition, in a study at the slaughterhouse in Hanoi, Le Bas et al (2006) reported that water used to wash carcass was highly contaminated, with 62% of positive samples (Le Bas et al., 2006), which might also allow cross-contamination to carcass, hand or floors. However, in this study we did not collected water samples.

5.1.1.2 Salmonella prevalence in pork markets

In this study, Overall *Salmonella* prevalence in the market was 41.4%, while *Salmonella* prevalence on pork was 42.9%. In comparison to results of other studies, our findings was lower than in a study in Mekong Delta, Southern Vietnam in 2005 (69.9%) (Phan et al., 2005). Study in Khon Kaen, northeast Thailand showed the *Salmonella* prevalence was 65% (Angkititrakul et al., 2005). This might reflect the condition of pork source, hygienic practices, or time of taking sample at market. In

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our study, we almost collected sample around 2- 4 hours after slaughtering pig.

In our results, *Salmonella* prevalence in the market was higher than prevalence in a study in Hue in 2009 (32.8%) (Takeshi et al., 2009). Our findings also showed a slightly higher prevalence than result in a study in Northern Vietnam in 2012 (39.6%) (Thai et al., 2012).

Our finding is higher *Salmonella* prevalence in market than result in a study in Northern Thailand (2010) which showed *Salmonella* prevalence was 34.5% in retail pork (Sanguankiat et al., 2010). Moreover, a study in Belgium (2009) reported a much lower prevalence in minced meat at retail level ranging from 0.3% to 4.3%. (Delhalle et al., 2009) and a study in Irish retail pork in 2009 (2.6%) (Prendergast et al., 2009) or in Italy in 2008 (15%) (Bonardi et al., 2008). Again, these numbers might show the different location, time and market/retail, hygienic condition, ect, and the range of *Salmonella* prevalence on pork at markets in this study also ranged from 17.2 to 69%.

When compared prevalence in the market among 3 districts, there was the highest *Salmonella* prevalence (69%) in district C and lowest in district A (17.2%), which might refer to the source of pork, carcasses from slaughterhouse, which was higher in slaughterhouse C than slaughterhouse A. It also can be explained by the hygiene at the shops where the cross contamination were three times higher between district C and A. By using Fisher' exact test between negative and positive pork samples, there was a statistically significant difference about *Salmonella* prevalence among the 3 districts (p- value = 0.0018, Fisher' exact test).

5.1.2 *Salmonella* number in pig slaughterhouses and pork markets

5.1.2.1 Salmonella MPN in pig slaughterhouses

In this study, workers' hands had a *Salmonella* MPN ranging from 0-7 MPN/hand. Others samples gave a number that was lower than the detection limited of the MPN tables (<0.3 MPN/g (belly skin) and < 1.2 MPN/cm^2 (cutting board)).

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Those were in accordance with findings of Prendergast (2008) reporting *Salmonella* MPN in environment pork cuts within a range of <0.03–0.36 MPN/g and in environmental swabs ranging from <0.03–1.1 MPN/cm^2 (Prendergast et al., 2008). There were few studies on number of *Salmonella* on workers hands or cutting board and on carcass. However, from our finding, the low quantitative number of *Salmonella* on carcass surface, belly skin, and on cutting boards was not unexpected. The few available MPN-based studies also indicate that low range.

A study in U.S. commercial pork processing plants observed a *Salmonella* MPN on pre-scald carcasses as >1.9 log CFU/100cm^2 (Schmidt et al., 2012). A study in Belgium (2009) reported the level of *Salmonella* contamination (semi-quantitative analysis of data) carcasses, equal to -3.40 ± 2.04 log CFU/cm^2 (Delhalle et al., 2009).

If this study shows a low number of *Salmonella* on carcass, if the condition at downstream like transportation, market, storage time or home handling were not appropriate, *Salmonella* can multiply and then increase the hazard for cross-contamination and consumption.

5.1.2.2 Salmonella MPN in pork markets

The number of *Salmonella* on pork samples ranged from less than 0.3 MPN/g to 15 MPN/g. This result was lower range than findings in a study from Italy in pork products (19 MPN/g (in pork sausages), mean value at 21.16 MPN/g (in fresh meat, heart and tongue samples) (Bonardi et al., 2008). The MPN of *Salmonella* from minced pork in a study in Germany showed the majority of the samples below 1,000 MPN/100g (Sinell et al., 1990). The lower in comparison can explain by the type of sample which we used were fresh pork when other studies analyzed sausage and tongue samples or mince pork. That might refer to the time and temperature, pH, etc in relation to bacterial multiplication.

The range from less than 0.3 MPN/g to 15 MPN/g in our study was higher than findings in a study in Irish retail pork (2009), which was at numbers between

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<0.03 and 2.10 MPN/g (Prendergast et al., 2009). In a Belgian pork meat chain (2009), the level of *Salmonella* contamination was estimated from a semi-quantitative analysis relating to cuts of meat and minced meat being equal to -2.64±1.76 log CFU/g and -2.35±1.09 log CFU/g, respectively (Delhalle et al., 2009).

5.1.3 Risk factors of *Salmonella* contamination

5.1.3.1 Risk factors of Salmonella contamination in pig slaughterhouses

In this study, potential factors, which might be due to hygienic condition and slaughterhouse management, were not statistically significant. However, the sample size from each slaughterhouse might be increased to get better number for analyses. Even though, among potential risk factors, the odds for *Salmonella* presence ranged from 1.3-10.5. “Free entry slaughter area”, “Time in lairage”, “Disease situation in farm area (in 6 months recently)” should be considered for *Salmonella* contamination control.

Distance to the slaughter area, free entry of butchers or workers might impose a high risk of spread *Salmonella* from live pigs to the slaughterhouse environment which then may cross over to the carcass. Hurd (2002) showed that transport and lairage were important risk factors for *Salmonella* contamination (Hurd, 2002). So, handling and hygiene practices are necessary to prevent cross contamination throughout the slaughtering process (Alban, 2005). Hald (1999) identified the floor as an important source of pathogens including *Salmonella* (Hald, 1999). A review on hazard from slaughter pigs described the need of distinguishes among herds in order to separate low or high-risk herds (Fosse et al., 2009). A study of Rostagno reported the need of attention on the lairage as a significant hazard for *Salmonella* contamination in the preharvest pork production chain (Rostagno et al., 2003).

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A study in Ireland (2010) demonstrated that lairage was a main source of cross-contamination with *Salmonella* as were the hands of evisceration operaters, conveyor belts, and equipment in the boning hall. Cross-contamination within the

slaughterhouse environment accounted for up to 69 % of *Salmonella* carcass contamination (Duggan et al., 2010). Whereas evisceration has been described in Europe as the major cause of carcass contamination (Berends et al., 1997). A study in Belgian pig slaughterhouses revealed that hygienic practices such as scalding with steam, complete cleaning and disinfection of the splitting machine several times a day were beneficial to reduce *Salmonella* (Delhalle L, 2008).

5.1.3.2 Risk factors of Salmonella contamination in pork markets

Four risk factors at pork markets were significant associated to *Salmonella* positive results: wood table surface, using bucket water, cutting on table surface and selling both retail and wholesale. These factors might relate to cross-contamination in shops, where the wood table surface might not be washed or cleaned appropriately and wood may have an absorption ability to retain bacteria including *Salmonella*. Using bucket water might refer to spreading bacteria after washing (hand, cloth, knife…), many time without hygienic awareness. The selling type of both retail and wholesale might relate to amount of pork/carcass on table(s), increase manually activities and more personnel contact within the shop. At a certain management at retail, to keep facilities and handling under hygienic condition with too much pork on the table might not be possible to maintain long.

Observation from Ireland indicated that a direct association between *Salmonella* contamination of pork cuts and equipment or/and surfaces might exist (Prendergast et al., 2008). After slaughter, the most important parameter with regard to contamination were handling, general hygiene, time and temperature at each stage (Wong et al., 2002). Hansen et al. (2010) described, that hygiene performance, particularly at retail, had a significant impact on the occurrence of *Salmonella.* To improve risk assessment of *Salmonella* in fresh pork meat, there need to get comprehensive retail data (Hansen et al., 2010).

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5.1.4 *Salmonella* serotype in pig slaughterhouses and pork markets

5.1.4.1 Salmonella serotypes in pig slaughterhouses

In this study, the most frequent serotypes in pig slaughterhouses were *S.* Typhimurium and *S.* Derby (19.4%) and *S.* Rissen (16.1%) and one serotype poly II. All of 8 serotypes (poly I) present in slaughterhouse were also mostly found on pig carcass. *S.* Derby, *S.* Meleagridis and *S.* Rissen were detected on all 3 sample types which might explain the cross contamination within carcasses, workers' hands and cutting boards. The main serotype in each slaughterhouse might be due to the difference location as well as pigs' source. Those some major serotypes are also high prevalence in pigs in Vietnam (Thai, 2007), so it can be introduced to slaughterhouse and carcasses.

In another study in Vietnam (2006) all types of sample (live pig, carcass, pork) S. Anatum (26.1%) and *S.* Typhimurium (20.7%) were detected as the most common serotype, followed by *S.* Weltevreden (15.3%), *S.* Derby (11.7%) and *S.* Rissen (11.7%) (Vo et al., 2006b). It showed almost similar to our finding, except *S.* Anatum.

Our findings are accordance with the study in the Netherlands (2012) related as to prominent serotypes as well as to number of serotype (7 serotypes): *S.* Derby (41%) and *S.* Typhimurium (29%) (van Hoek et al., 2012). In Ireland (2008), the predominant serotype was *Salmonella* Typhimurium, followed by *Salmonella* Derby (Prendergast et al., 2008). Another study in US in pork processing plant indicated that *S.* Typhimurium and *S.* London were the most common of the 24 serotypes isolated from preevisceration carcasses and the *Salmonella* Johannesburg and *S.* Typhimurium were the most frequently isolated serotypes of the 9 serotypes found from chilled final carcasses (Schmidt et al., 2012).

Because *S.* Typhimurium is a dominant serotype, followed by *S.* Enteritidis and *S.* Weltevreden isolated from humans in Vietnam (Vo et al., 2006b), so, the presence of *S.* Typhimurium, *S.* Derby, *S.* Weltevreden in slaughterhouse might be an

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important potential hazard that could cause *Salmonella* infections in humans along the chain.

5.1.4.2 Salmonella serotypes in pork markets

In this study, serotype most frequently found was *S.* Derby (19.4%), followed by *S.* Anatum and *S.* Meleagridis (16.7%), *S.* London and *S.* Rissen (13.9%), *S.* Bovismorbificans, *S.* Give, *S.* Stanley and *S.* Weltevreden (2.8 – 5.6%). A study in Northern Vietnam in 2012 (Thai et al., 2012) showed almost the same trend of prominent serotypes (*S.* Anatum (19.8%), *S.* Derby (15.9%), except *S.* Infantis (13.5%), *S.* Typhimurium (13.5%) and *S.* Reading (7.9%), *S.* Newport (6.3%)). Other finding in South Vietnam reported that the predominant serotypes of the isolates were *S.* Derby, *S.* Weltevreden, and *S.* London in pork as well as *S.* Bovismorbificans in retail meat (Phan et al., 2005).

In a study in Thailand (2005), the most prevalent serotype in pork was *S.* Rissen (61.5%), followed by *S.* Stanley and *S.* Lexington (11.5%) (Angkititrakul et al., 2005). A study in Germany (2011) showed currently one major *S.* Derby clone frequently isolated from pigs and humans. Contaminated pork was recognized as one vehicle and consequently is a risk for human health (Hauser et al., 2011). A study in Taiwan detected twenty *Salmonella* serotypes, among them, *S.* Derby, *S.* Anatum, *S.* Typhimurium, and *S.* Schwarzengrund were the most frequently isolated, accounting for 76% of the strains (Chen et al., 2006).

S. Anatum, *S.* Derby and *S.* Meleagridis were mostly found in pork markets in district C. *S.* Rissen was dominant in pork markets in district B. *S.* Anatum was present in all three districts. Serotype group E was the main serotypes in district C, which was the same trend with slaughterhouse C. As mentioned, serotype *S.* Typhimurium, S. Rissen and *S.* Weltevreden were frequent isolated from humans in Vietnam and Thailand (Angkititrakul et al., 2005, Vo et al., 2006a). In our study, presence of S. Rissen and *S.* Weltevreden was from 5.6-13.9% and *S.* Typhimurium was not detected in the market.

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5.1.4.3 Salmonella prevalence and serotypes during 2 consecutive sampling occasions.

This study was conducted to observe the dynamic of *Salmonella* presence and MPN along two points (slaughterhouse and market) of the chain. Positive and negative results at slaughterhouse and at market did not always indicate the same direction. Carcasses may be further exposed to different magnitudes during transportation or at market by vertical or horizontal contamination.

For the number of *Salmonella* on carcass or pork, results were expected to describe, in general, the multiplication (with time, temperature, pH, etc) of *Salmonella* or cross-contamination (duration, degree, hygiene situation, etc). However, it needs more detail information at least at serotype level to explain the presence of *Salmonella*. From the result of 10 positive samples (5 carcasses and 5 pork samples which aligned in pair), only one carcass sample had the same serotype as pork, which might raise suspicion to be from carcass. Four other pairs of samples were not the same serotype, which could refer to cross-contamination at transportation or at market (Table 20).

The distribution of *Salmonella* serotype in samples from carcasses, slaughterhouses' environment, pork and markets' environment showed the pattern. *Salmonella* serotype detected might originate from many sources (live pig, flora from slaughterhouse/market facilities, water, people, etc) and could circulate and cross-contaminate to others. In this study, *S.* Derby, *S.* Rissen and *S.* Meleagridis were detected from carcasses, pork, as well as environment samples and dominated other serotype, whereas, *S.* Bovismorbificans and *S.* Stanley were only present at the market, *S.* Typhimurium was only found in slaughterhouse.

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5.1.5 People and relevant stakeholders' perception related to food safety

Our study applied an integrated approach in combining quantitative (*Salmonella* contamination) and qualitative (FGD and IDI) data collection, a method which hasn't been used yet or often in Vietnam. The empirical evidence for contamination of pork is important to quantify risks. But it is also crucial to understand why certain groups or actors do something "wrong" which may lead finally to a contaminated product. Both have similar importance as behavior can be only changed when we understand the reasons behind.

At slaughterhouse:

Some practice related to avoid contamination of carcass seems to be intently properly applied (e.g. avoid puncture of carcass or wash pig and carcass in many steps). However, they used cloth (one/day) to dry the carcasses. This practice could be perfect for cross contamination if the cloth comes to a harbor of *Salmonella*. More importantly, workers think that this is an appropriate practice. Discussed groups mentioned using gloves, mask to protect their health and limit contamination. Anyhow, our observations indicated the opposite. It is understandable that workers even though having some awareness to keep good hygienic e.g. by using gloves, they feel uncomfortable when using them. In fact, our study showed that there is a high chance to find *Salmonella* on worker hands. Thus, it is interesting to note that a little improvement of the practices could considerably reduce the carcass contamination.

In addition, slaughter workers group stated that they "trained by doing" among themselves rather than get trained from related authorities. They follow their own "internal" rules. Source of information for them was mainly due to mass media and not at all from public health or veterinary services. This finding is interesting as public health and veterinary groups stated a lot of training activities being organized. It shows that there is a need for more adequate and standard information of slaughterhouse workers through training. This gap is currently addressed by the Livestock Competitiveness and Food Safety Project (LIFSAP). The project targets

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improvement and upgrade of facilities including training at slaughterhouses (ILRI, 2010). Hung Yen is 1 of the 12 provinces in Vietnam under this project.

According to the regulation, slaughterhouses have to be separated from the residential area (at least 100 m) and have to use appropriate waste treatment system (MARD-MOIT, 1997). All 3 slaughterhouses use biogas for waste treatment. However, due to the limited land area and initially starting from a traditional practice "household based" slaughterhouse, all three slaughterhouses are not able to follow this regulation. This may due to the limit of investment opportunities and mechanism of land used which constrain the build a new and separate slaughterhouse. It is obvious that the presence of slaughterhouse within communities could expose disadvantages for human, animal and environment (such as smell, risk of disease transmission, etc). It should be noted that interviewed *people living around slaughterhouse* seem to be familiar with slaughterhouse presence and feel only minor disturbed or not at all. Anyhow, almost all respondents (workers, people living around, veterinary and public health staffs) expressed the hope of moving and management slaughterhouse in the separate area as regulation.

At markets:

Our findings from this group showed the practice of using wooden tables because of their perception that meat looks longer fresh, following a consumer driven demand here. Sellers groups discussed also the fact that a wooden table surface might be risk factors of *Salmonella* contamination however they still prefer to use it because of their perception. This miss perception should be specifically addressed in future training activities. Sellers at almost all pork shop use clothes to wipe pork "dry" or for hands or equipment, a practice as already mentioned above for slaughterhouse workers. The cloth may be a good carrier for contamination. In addition, using of masks, gloves or hat by sellers may give the perception that some consumers might be afraid that they have "hidden" health problems.

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As mentioned above, the government currently implements the LIFSAP project which plans also to upgrade facilities in selected open fresh food markets. The project supports the use enamel/granite surfaced tables, as well as floor, roof, carcass cutting and retailing tables, and sewage and waste management systems. Some of sampled markets (in Hung Yen) were under this investment replacing wooden tables by stainless steel ones or providing pork retailers with hangers to hang carcass (ILRI, 2010).

Under regulation, the actors who involve meat production such as slaughter workers and owner, meat seller, meat processor, etc have to have health check certificate once a least (MARD-MOIT, 1997). Through this investigation, this was a certain concern in pork sellers, and a few in slaughterhouse workers group.

In our study, color, smell of pork is the most important selection criteria for purchasing pork. Lowest important has price. “Wet” looking pork among other criteria, was one indicator for consumer for low quality of pork. This can be related to sellers’ practice of continued drying the meet using clothes. In a previous study in Hanoi and Ho Chi Minh City, accessibility, availability and tradition were strong drivers of preference for the choice of market for fresh pork in Vietnam. It also indicated that the consumer prefers to buy fresh pork from our finding, however, accessibility was less important. The observed difference between both studies might be related to the varying of lower distances of access to markets as well as a limited number the interviewee compare to previous study. Moreover, trust on sellers/butchers was also mentioned in our study as one important criterion in selecting pork. This drives the decision in market outlet choice for fresh pork supply (Lapar et al., 2009).

More interestingly, from the perspective of consumer when selecting pork, price has lowest important. In contrast, a study in Germany stated that price was of one of top three responses by consumers with 66% of the responders mentioned the price, 37% of the participants called for freshness/not spoiled, 15% appearance, 15% ingredients (fat, sugar, nutritive value) (Rohr et al., 2005). Here, our finding on freshness and nutritive value criteria were also in the line with result from Rohr et al.

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Other study in Vietnam reported people had high trust in pork safety and quality and rarely attributed health issue to pork consumption.

A cross cutting synthesis of our finding related to zoonoses revealed that almost all actors had little knowledge or some misperception on zoonoses. Surprisingly, this applies also to a certain level to interviewed veterinary and public health staffs. This finding is also in agreement with results from an ongoing study on consumer perspective in Vietnam (Hung et al., 2012).

In fact, information on zoonotic diseases which almost related to urgent or novel zoonoses such as avian influenza, streptococcus susis, particularly was sensitive with people by mass media (TV, internet, etc). This information was also mentioned from the discussion and interviews in study. Some of other zoonotic diseases which was mentioned by respondents was leptospirosis and cysticercosis. That might refer to situation of disease when they sporadically observed or heard or are event experienced, particularly for cysticercosis in some decades ago. The study in 2 provinces in South Vietnam reported that as yet, no mechanism in Vietnam links disease reporting between animal and human health. Therefore, this missing link makes it hard for researchers in both sectors to understand how changes in the environment or behaviour may affect zoonotic diseases (ILRI, 2013).

Under consumer perspective, a survey in 2010 in Vietnam reported a high level of contamination in pork sold in Ha Noi and Ha Tay, 90% of samples did not meet accepted levels. However, there is little evidence that hazard in pork present a risk to human health. This could be explained by the retailer and consumer practices which reduce risk such as proper cooking, short time between slaughter and sale and between sale and consumption (Grace, 2010). Such little evidence was demonstrated in our survey by almost all respondents (FGD and IDI) answered that there was seldom of human illness by consuming pork in their family in 6 to 12 months recently. However, due to limit on sample size and sensitivity of study, in depth studies on consumer level are required to quantify the risk originated from the demonstrated hazard, here *Salmonella* in pork.

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5.2 Conclusions

In this study, on slaughterhouse level, the prevalence of *Salmonella* was 36.9% in overall. *Salmonella* positive on carcass was 34.9% of cases. The number of *Salmonella* on carcass was lower than 0.075 MPN/cm^2 and on workers' hands, it ranged from 0-7 MPN/hand. The most frequent *Salmonella* serotypes were *S.* Typhimurium and *S.* Derby (19.4%). Other *Salmonella* serotypes detected were *S.* Rissen, *S.* London, *S.* Meleagridis, *S.* Weltevreden, *S.* Give and *S.* Anatum.

At the markets, the prevalence of *Salmonella* was 41.4% in overall and 42.9% in pork, 33.3% on sellers' hands and 41.7% on cutting boards. The predominant *Salmonella* serotypes found at markets were *S.* Derby (19.4%), *S.* Anatum and *S.* Meleagridis (16.7%), *S.* Rissen and *S.* London (13.9%), followed by *S.* Bovismorbificans, *S.* Give, *S.* Weltevreden. *Salmonella* number on pork ranged from <0.3 to 15 MPN/g. The number of *Salmonella* on sellers' hands and cutting board were 4.6 MPN/hand and 0.368 MPN/cm^2, respectively.

Among 3 studied districts, no significant difference on *Salmonella* prevalence was found in slaughterhouses. At the market, there was significant difference on *Salmonella* prevalence in pork (p-value =0.0018). Risk factors of pork *Salmonella* positive were using wood table surface, bucket (mobile) water, cutting on table surface and selling both retail and wholesale.

The survey on perception and hygienic practice related to food safety by relevant groups and stakeholders provided basic information and contribute a better understanding of their practice. It demonstrated several risky practices which may lead to *Salmonella* contamination along the chain. It also shows the need for a better understanding of practice and behavior before certain interventions are designed and introduced.

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For directly involve groups such as slaughter workers and pork sellers, there is a need of standards and targeted training. Proper training will help to fulfill the

requirement of work as well as to enhance the assurance on food safety in both production and consumption sides.

Findings from our study provide information on *Salmonella* contamination and related risk factors in slaughterhouses and markets in Hung Yen in particular and in Vietnam in general. From those points, we have a better understanding on groups or actors in the pork production chain such as slaughterhouse workers, butchers, pork sellers, veterinary or public health staffs so that it helps to better engagement in management. So, knowledge and information on food safety, foodborne disease or zoonoses can be disseminated effectively to the public. Improving collaborative mechanism is necessary to manage the food production chain properly and comprehensively.

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