5. DISCUSSION AND CONCLUSIONS

5.1 Discussion

This study was conducted on the prevalence of *Salmonella* in sow of an integrated pork production company in the region of Chiang Mai province, Thailand. The sows were kept in two housing systems with same management. The study design and time schedule chosen could be carried out without any difficulty. The company and farm workers supplied well any helping and information. This reflects the company's approach of a transparent food safety policy for all their production lines. The company's policy also principally supported and regulated by the Ministry of Agriculture and Cooperatives and Ministry of Health of Thailand. The results from this study are expected to provide useful information for further improvements for the company's policy in regards to their pork production.

5 .1 .1 Materials and methods

The isolation method of *Salmonella* followed ISO 6579 (2002). Pre-enrichment used buffered peptone water in order to stimulate *Salmonella* growth, because the sample materials were likely to contain low numbers of *Salmonella*. The selective media used two media in parallel, Tetrathionate and modified semisolid Rappaport-Vassiliadis (MSRV). MSRV, a semisolid supplemented with Novobiocin supplement allows the detection of *Salmonella* in foodstuff, environment specimens and chocolate products by motility testing. It is the most sensitive medium tested and is a very specific medium for the isolation of non-typhoidal salmonellae from stool specimens (Dusch and Altwegg, 1995). The medium was prepared according to the typical formulation of De Smedt *et al*. (1986). However, its semisolid nature is a disadvantage and requirs careful handling in the laboratory and is not suitable for the detection of non-motile strains of *Salmonella.* Subsequently, solid selective enrichment BPLS and XLT_4 were used to inhibit other competing bacteria. XLT_4 has a nearly 100% specificity and can be

regarded as an alternative for isolation of nontyphoidal salmonellae from stool samples (Dusch and Altwegg, 1995). It has a high degree toward inhibition and essentially in eliminating false positive colonies.

The ELISA test is the preferred method in large scales monitoring programs. It can be applied to meat juice and serum. ELISA is the most sensitive and economic method of monitoring the exposure of pigs to *Salmonella* and detecting previous infection in pigs. However, it might not detect recently exposed pig due to the lag period between exposure and the development of humeral antibodies. Therefore, the herd is categorized positive with the ELISA test at early exposure; the antibodies level could not detected and indicated of seronegative when the pigs reach to slaughter weight.

5 .1 .2 Result of isolation

In this investigation *Salmonella* prevalence in the breeder sows were divided into the prevalence in sows from open and close housing systems. The investigation followed the animals though the farrowing stages in both housing systems. In both housing system the prevalence was the same 20% (2/10, 95% CI =3.54-55.78). Hence, sows from both housing systems had been infected with *Salmonell*a that might be transfer to their piglets.

The distribution of *Salmonella* prevalence in sow herd was assumed as 20%; also the investigation of Davies *et al*. (1998) reported a 18-22% prevalence in breeding animals. Letellier *et al.* (1999) found that *Salmonella* positive in replacement sows and gilts were 15.9 % and 21.9% respectively, they concluded that vertical transmission was occurring throughout the different production stages.

In comparison with the investigation of Sangvatanakul (2007), *Salmonella* prevalence in piglet before weaning in the close house was 0 %, while in the piglets from sow in the open house was 5 % (1/20). This result implied that the prevalence in piglets were low although in sows (20%) it was high. It could be due to the

passive immunity in the piglets which might still work. Proux *et al*. (2000) reported that maternal antibodies persisted until 7 weeks of age and post *Salmonella* contamination seroconversion was detected from 8 weeks of age onwards. Therefore, this study the sow may not serve as a major source in maintaining *Salmonella* infection for finishers. But, they can play an important role in the transmission to the other herds within the farm and other farms.

Dorn- in (2005) determined an average herd-level prevalence of 62.9% for pre slaughter pigs from investigations of faeces at the fattening farm in Chiang Mai, Thailand. Those farms received the weaned pigs from the sow compartment in this study. The transportation of weaned piglet to the fattening unit might cause stress and induce animals to shed *Salmonella* within the batch. The study of Hurd *et al* (2002) demonstrated that rapid infection during transport, and particularly during holding, is a major reason for the increase of *S. enterica* in swine. The findings identified the holding pen as also an important control point in the pork production line.

When comparing open with close housing management, the environmental prevalence in the open house farm (22.22 %) was double the prevalence in the close house farm (11.11 %). Most *Salmonella* isolates were found in pen swabs. Indicating that not only the sows might be contaminated with *Salmonella* from the environment but also the environment contaminated from the infected sows. The investigation of Callaway *et al*. (2005) indicated that pathogenic bacteria were cycling between swine and their environment.

5.1.3 Serotype of isolates

Of the 20 investigated sows, four sows were *Salmonella* positive, two with *S*. Rissen, one sow with *S*. Stanley, and the forth are a *S*almonella rough strain. The most frequent serotype determined in positive samples from sows and environment was *S*. Rissen 57.14% (4/7. The other positive samples were *S.* Stanley 14.28%

(1/7), *Salmonella* rough strain 14.28% (1/7), and *Salmonella* groups II; F-67 14.28% (1/7). The percentage of serotypes in breeder sows compared with piglets and fattening pigs (Dorn-in, 2005; Sangwatanakul, 2007) is summarized in appendix C.

For comparison, *S.* Rissen and *S.* Stanley were ranked in 7th and 8th of the most frequent *Salmonella* serotypes from human cases. (Table 6, Bangtrakulnonth *et al.* 2004). During the last 10 years, in Thailand *S.* Rissen has been increasingly isolated from foodborne gastrointestinal infections in human cases (1.6% in 1993 to 8.2% in 2002) and 'other' food products (4.7% in 1993 to 14.7% in 2002) (Bangtrakulnonth *et al.* 2004). The reservoir of *S.* Rissen has not been identified yet, but the agent so far was frequently found in water and food products (Bangtrakulnonth *et al.* 2004). The results from Dorn-in (2005) indicate that pre-slaughter pigs and the environment in fattening pig farms are an important reservoir for *S.* Rissen, which correlates with this study.

S. Stanley is one of the most frequently serotype detected in pig production. The results of the study in pork production in Chiang Mai, Thailand (Table 5 and Appendix C) underlined that *S.* Stanley still exists in pig farms and in farms's environment (Chantong, 2005; Dorn-in, 2005; Sanguankait, 2005). Moreover, the number of isolates in Thailand from human food borne gastrointestinal infections has increased from 1.9% in 1993 to 6.4% in 2002 (Bangtrakulnonth *et al.* 2004).

5.1.4 Incidence of *Salmonella*

Incidence density in sows from both hosing system were nearly the same percentage during peripartureint period (over 17 days). If considered *Salmonella* incidence from day 7 to day 18 after delivery in sows from open housing system increased slightly (0% to 10%), while, in sow from close housing system it slightly decreased (11.11% to 0%), though both systems had the same management. Principally, the environmental temperature is influenced by the housing system.

Uncontrolled temperature might induce stress on the sows leading to shedding of *Salmonella* within that herd. To reduce the number of new *Salmonella* cases in breeder sows, farmers should change from open housing systems to close housing systems and follow the principle of Good Management Practice for pig farms. As the research of Berend *et al*. (1998) demonstrated, GMP could reduce the current level of *Salmonella* positive pig and pork by 50-60 %. Furthermore, Farzan *et al*. (2006) indicated that liquid-feeding and all in all out management of the grower-finishing herds can reduce the *Salmonella* prevalence. In order to control *Salmonella* at farm level, the farm management should apply good hygiene practice and all-in/all-out system. Moreover, efficient pest control and prevent cross contamination in the breeder sow compartment should be established.

5.1.5 Results of *Salmonella* antibody testing from serum samples

Here it was test used for detecting antibodies to *Salmonella* in a breeder sow herd by examining serum collected from individual sows. The estimated sensitivity and specificity of the Danish mix – ELISA used the original and possibly modified cut-off value 40%, which was deemed optimal with sensitivity of 75.5% (32.565-100) and a specificity of 68.75% (46.038-91.462) by using *Salmonella* isolation as a gold standard. Information on the sensitivity and specificity of the test provided the ability to estimate the true prevalence given the seroprevalence by solving the following equation for the prevalence:

Seroprevalence = Sensitivity * Prevalence + Specificity* (1-Prevalence)

Sample size calculations can be undertaken to determine the number of animals to be sampled and how often, given the size of the herd and the true prevalence of which it is a concern to detect (van Winson *et al*., 2001).

5.1.6 Correlation between the number of *Salmonella* isolations and Danish mix- ELISA results

At the individual pigs' level, results of the ELISA test demonstrated a moderate agreement (kappa value = 0.318) between the *Salmonella* antibody status in the sera of the sows and the definite diagnosis from bacteriology. Meaning, there was a poor correlation between serological and bacteriological culture result. The 95% confidence intervals for the kappa values further indicate that these estimates did carry a large degree of uncertainty (-0.072-0.709). In contrast in slaughter pigs in Denmark, there was very strong association between serology and *Salmonella* isolations from caecal content, pharynx and carcass surface (Sorensen *et al*., 2004).

The prediction of the *Salmonella* status by antibodies in sow herd in the open housing system (50%) was higher than sow in the close housing system (30%). While, the results of *Salmonella* isolation in both housing system were at the same level (20%). The investigation of Korsak *et al*. (2006), indicated that the correlation of serological and culture result, if the batch was serological positive, the probability of *Salmonella* recovery in cecal content was higher than when the batch was considered as negative.

5.2 Conclusion

In Chiang Mai, the prevalence of salmonellae in pigs was at a very wide range (6-69.5 %). Therefore, it might lead to increase the incidence of salmonellosis in pigs though to the consumers. Particularly pre-slaughter pigs are indicated as the principal reservoir. *Salmonella* in the environment played one major role of cross contamination into pig herds as same as the results in this thesis, the most frequency serotypes in sow and their environments was *S.* Rissen, indicated the cycling of salmonellae between sow and their environments.

This study is part of *Salmonella* investigation conducted along the pork production chain in Chiang Mai, Thailand. The particular focus of this study was

established an impression a *Salmonella* prevalence and incidence in breeder sows. Bacteriological laboratory investigation for *Salmonella* infections of individual breeder sows after delivery followed international standard methods (ISO 6579: 2002). A Danish mix- ELISA test was used for serological screening of *Salmonella* infection at sow herd level.

The correlation between the number of *Salmonella* isolations and Danish mix-ELISA results was poor. However, using the strengths of both methods and compensating for their weaknesses, serological testing can be used as a monitoring tool, indicating exposure to *Salmonella* at one point during production, and bacteriological testing as a means to confirm and locate a current infection in herds should be desired. However, two test measured at the difference stages of Salmonella infection, therefore can not be easily compared.