

CHAPTER III

RESULTS

Salmonella bacteria prevalences

A total of 924 test samples were obtained from 308 slaughter pigs and were cultured for *Salmonella* bacteria. Overall, *Salmonellae* were detected in 82.4% (254/308) of the total samples (mesenteric lymph nodes or fecal samples). In the Muang and Sansai slaughterhouses, *Salmonella* bacteria were isolated in 84.3% (113/134) and 81.03% (141/174), of the pigs investigated, respectively. These two proportions were not significantly ($\chi^2= 0.57$; $df= 1$; $P=0.45$) different. The overall sample-specific prevalences for mesenteric lymph nodes, fecal samples and surface swabs were 69.48% (214/308), 54.87% (169/308), and 53.24% (164/308), respectively (Table 7).

The highest prevalences per sample type of 65.7% and 72.4% of *Salmonella* bacteria in both slaughterhouses, Muang and Sansai, were detected in the mesenteric lymph nodes. These were followed by those of fecal samples (58.2% and 52.3% in Muang and Sansai slaughterhouses, respectively) and carcass swab samples (60.4% and 47.7% in Muang and Sansai slaughterhouses, respectively) (Table 8, Figure 8). These sample-specific prevalences were not significantly different for the Muang slaughterhouse (overall $\chi^2=1.66$, $df=2$, $P=0.44$).

For Sansai slaughterhouse, in contrast, *Salmonella* bacteria were significantly more frequently isolated from the mesenteric lymph node samples than from fecal

<i>Salmonella</i> detection	Prevalences(%)	95% CI
Mesenteric lymph nodes	69.5	64.3-74.6
Feces	54.9	49.3-60.4
Carcass swabs	53.2	47.7-58.8
Negatives	13.6	9.8-17.5

Table 7. *Salmonella* detection in both slaughter pigs (Muang and Sansai Slaughterhouse)

Slaughterhouse	Sample	Prevalences (%)	95% CI
Muang	Mesenteric lymph nodes	65.7	57.6-73.7
	Feces	58.2	49.9-66.6
	Carcass swabs	60.4	52.2-68.7
Sansai	Mesenteric lymph nodes	72.4	65.8-79.1
	Feces	52.3	44.9-59.7
	Carcass swabs	47.7	40.3-55.1

Table 8. Comparison of slaughter pig sample-specific *Salmonella* prevalences between Muang and Sansai slaughterhouse

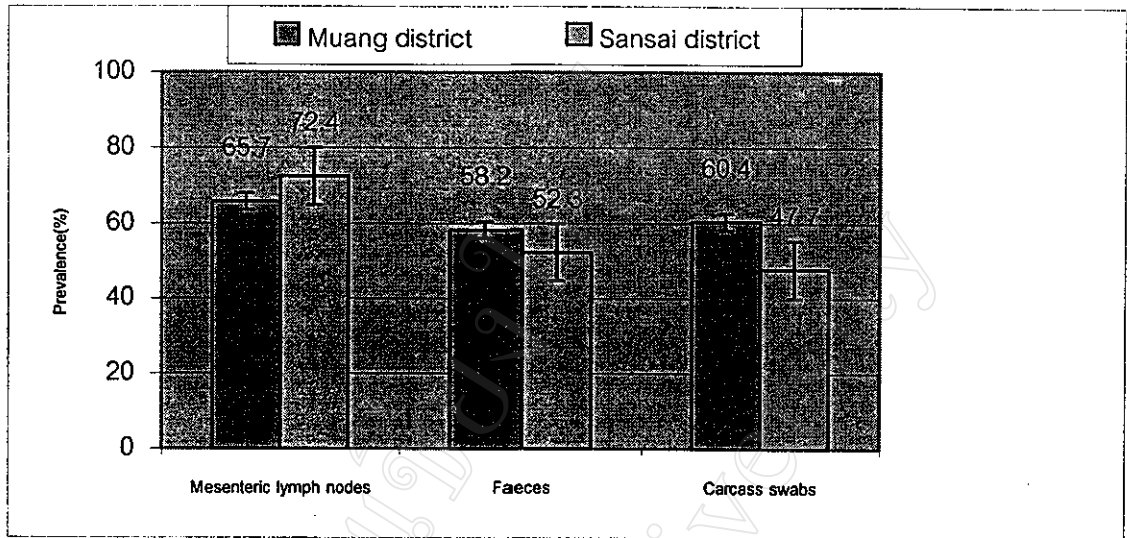


Figure 8. Prevalences of *Salmonella* in difference tissues of slaughter pigs

($\chi^2=15$, $df=1$, $P=0.0001$), and from surface swab samples ($\chi^2=22.15$, $df=1$, $P=0.000002$). The differences for prevalences of *Salmonella* bacteria between in fecal and surface swab samples were not significant ($\chi^2=0.74$, $p\text{-value}=0.39$) (Table 9).

Tables 10 and 11 summarize the results of the identified *Salmonella* serogroups isolated from the various samples. Since the total number of *Salmonella* isolations from the two slaughterhouses was not significantly different, results from both places were pooled and were related to the total number of sampled slaughter pigs. Table 9 gives an account on the number of *Salmonella* recovered from single sample types and from combinations of the 3 individual sample types.

Herd level pre-slaughter infection of pigs with *Salmonella* bacteria

If the percentage of *Salmonella* isolation from mesenteric lymph nodes is considered an estimate of the herd-level prevalence, pre-slaughter infection at individual farms ranged from 50% to 83.3%, with an overall prevalence of 69.5% for the total of farms (see Tables 12a and b). The overall prevalence of pre-slaughter *Salmonella* infection at the slaughterhouse level on the other hand was as high as 80.5%. This suggests that about 13% cross-infection occurred during transportation and at the lairage (% found from fecal samples, as shown in Table 13).

Chain of infection and their risk factors

The chain of *Salmonella* infection into pork for consumption is composed of the prevalence of infection at the farm level of 69.5 % to which further infection due to shedding of agents and subsequent cross-infection during transportation and during the holding period at slaughterhouses is added. The resulting total prevalence pre-slaughter was 80.5%.

Slaughterhouse	Testing	χ^2	p-value
Muang	Mesenteric lymph nodes (65.7%) VS Feces (58.2%)	1.58	0.2
	Mesenteric lymph node (65.7%) VS Carcass swabs (47.7%)	0.78	0.37
	Feces (58.2%) VS Carcass swabs (47.7%)	0.14	0.7
Sansai	Mesenteric lymph node (72.4%) VS Feces (52.3%)	15	0.0001
	Mesenteric lymph node (72.4%) VS Carcass swabs (47.7%)	22.1 5	0.000002
	Feces (52.3%) VS Carcass swabs (47.7%)	0.74	0.39

Table 9. Statistical comparison of *Salmonella* identifications between various tissues samples

Slaughter ID.	Samples	Serogrouping	Percent (%)	Cumulative percent (%)
Muang	Mesenteric Lymph Nodes	Gr.B	13.4	13.4
		Gr.C	30.6	44
		Gr.D	1.5	45.5
		Gr.E	20.2	65.7
		Negative	34.3	100
	Feces	Gr.B	9.7	9.7
		Gr.C	25.4	35.1
		Gr.D	5.2	40.3
		Gr.E	16.4	56.7
		Gr.F-67	1.5	58.2
		Negative	41.8	100
	Surface swabs	Gr.B	14.2	14.2
		Gr.C	26.8	41.0
		Gr.E	18.7	59.7
		Gr.F-67	0.7	60.4
Negative		39.6	100	

Table 10. *Salmonella* prevalences in Chiang Mai slaughterhouse by serogroups

Slaughter ID.	Samples	Serogrouping	Percent (%)	Cumulative percent (%)
Sansai	Mesenteric Lymph Nodes	Gr.B	23	23
		Gr.C	16.7	39.7
		Gr.D	8.6	48.3
		Gr.E	24.1	72.4
		Negative	27.6	100
	Feces	Gr.B	16.1	16.1
		Gr.C	10.9	27
		Gr.D	6.9	33.9
		Gr.E	18.4	52.3
		Negative	47.7	100
	Surface swabs	Gr.B	16.7	16.7
		Gr.C	10.3	27
		Gr.D	5.2	32.2
		Gr.E	15.5	47.7
		Negative	52.3	100

Table 11. *Salmonella* prevalences in Sansai slaughterhouse by serogroups

Slaughterhouse	Herd	Isolation					
		Serogroup	MLN (%)	Serogroup	Feces (%)	Serogroup	SS (%)
Muang	A	B	10.7	B	3.6	C	39.3
		C	46.4	C	32.1	E	10.7
		E	14.3	D	3.6	F-67	3.5
		-	-	E	17.9	-	-
		Herd Pr.	71.4	-	57.2	-	53.5
	B	B	50	-	-	B	100
		Herd Pr.	50	-	-	-	100
	C	B	4.8	C	33.3	C	40.9
		C	47.6	D	9.5	E	45.5
		E	23.8	E	19	-	-
		-	-	F-67	4.8	-	-
		Herd Pr.	66.2	-	65.6	-	86.4
	D	C	35	B	5	B	5
		D	10	C	30	C	10
		E	15	D	20	E	10
		Herd Pr.	60	-	55	-	25
	E	B	26.3	B	23.7	B	27
		C	18.4	C	18.4	C	21.6
		E	21.1	E	13.2	E	10.8
		-	-	F-67	2.6	-	-
		Herd Pr.	65.8	-	56.9	-	59.4
	F	B	13.6	B	9.1	B	27.3
		C	18.2	C	13.6	C	27.3
		E	31.8	E	36.4	E	27.3
		Herd Pr.	63.6	-	59.1	-	81.9
	G	-	-	C	66.7	-	-
		Herd Pr.	-	-	66.7	-	-

Table 12 A. Proportions of *Salmonella* serogroups in pig study herds of Muang slaughterhouse

Slaughterhouse	Herd	Isolation					
		Serogroup	MLN (%)	Serogroup	Feces (%)	Serogroup	SS (%)
Sansai	H	B	8.3	B	8.3	B	4.2
		C	20.8	C	16.7	C	20.8
		D	29.2	D	12.5	D	16.7
		E	25	E	12.5	E	8.3
		Herd Pr.	83.3	-	50	-	50
	I	B	28.6	B	14.3	B	35.7
		C	7.1	E	21.4	E	14.3
		E	14.3	-	-	-	-
		Herd Pr.	50	-	35.7	-	50
	J	B	41.7	B	33.3	B	35.7
		D	8.3	D	16.6	E	14.3
		E	33.3	E	41.7	-	-
		Herd Pr.	83.3	-	91.6	-	50
	K	B	25.9	B	17.3	B	14.8
		C	23.5	C	13.6	C	16
		D	3.7	D	8.6	D	4.9
		E	25.9	E	14.8	E	14.8
		Herd Pr.	79	-	54.3	-	36.1
	Others	B	18.6	B	13.9	B	18.6
		C	9.3	C	9.3	D	2.3
		D	9.3	E	20.9	E	20.9
		E	20.9	-	-	-	-
		Herd Pr.	57.1	-	44.1	-	41.8
Total	-	69.5	-	54.9	-	53.2	

Table 12 B. Proportions of *Salmonella* serogroups in pig study herds of Sansai slaughterhouse

Mesenteric LNs.	Faeces	Carcass Ss.	(%)
+	+	+	30.2
+	+	-	11.7
+	-	-	13.96
+	-	+	13.64
-	+	+	5.52
-	+	-	7.47
-	-	+	3.89
-	-	-	13.6

+ = *Salmonella* isolation

Table 13. Account on *Salmonella* isolations from mesenteric lymph nodes, faeces and carcass surface swab samples in individual pigs

To this further cross-contamination in the range of 55% must be added, as shown by the results of the carcass swabs investigation. These figures reflect the enormous hazard in pork. The statistical analysis between the two slaughterhouses revealed no differences in this general course and chain of infection and contamination. (Table 8). Only within Sansai slaughterhouse *Salmonellae* were more frequently identified in mesenteric lymph node samples than in fecal samples ($\chi^2=15$, p-value=0.0001), and surface swab samples ($\chi^2=22.15$, p-value=0.000002), whereas there was no significant statistical difference for *Salmonella* positivity between fecal and surface swab samples ($\chi^2=0.74$, p-value=0.39) (Table 9).

Applicability of Danish Mix-ELISA for *Salmonella* bacteria screening test

Based on the results in Table 14, the serogroup E1 which contains the antigens O: 3,10 and D2 (O: 9,46) only was prevalent in 32.1% and 9.4 % of cases in each of the two slaughterhouses respectively. The Danish Mix-ELISA, which contains the antigens O 1,4,5,6,7 and 12 therefore would be unable to recover all the antigens detected in this investigation for Thailand

Data (Table 15) from the National Institut of Health (1999) further show that in other investigations animals (species not indicated) were positive in at least 13% of cases for *S. Weltevreden* and in 3% positive for *S. Lexington*, both species belonging to group E1. The Danish Mix-ELISA also would not have detected these species.

Serogroup	Total	Percent(%)	Detectability by the Danish Mix-ELISA
B	99	25.85	All
C	123	32.11	All of C ₁ , most of C ₂ -C ₃ (via O ₆)
D	36	9.4	All of D ₁ , D ₃ (via O _{1,2,27}), none of D ₂
E	123	32.11	All of E ₄ (via O ₁), none of E ₁
Others	2	0.52	Depend on serogroup
Total	383	100	

Table 14. Percentages of *Salmonella* bacteria recovered by serogrouping

Animal	Isolates	%
<i>S.Choleraesuis</i>	19	15
<i>S.Typhimurium</i>	16	13
<i>S.Weltevreden</i>	16	13
<i>S.Java</i>	12	10
<i>S.Derby</i>	5	4
<i>S.Virshow</i>	5	4
<i>S.Enteritidis</i>	4	3
<i>S.Lexington</i>	4	3
<i>S.Saintpal</i>	3	2
<i>S.Senfittenberg</i>	3	2
Others	39	31
Total	126	100

Source: Annual Report of the Confirmed *Salmonella* and Shigellain Thailand during the Year 1999; National Institute of Health, Department of Medical Sciences, Ministry of Public Health, Thailand)

Table 15. Most frequently isolated *Salmonella* serotypes from animal sources during Jan-Dec 1999 (Annual Report of the Confirmed *Salmonella* and Shigellain Thailand During the Year 1999; National Institute of Health, Department of Medical Sciences, Ministry of Public Health, Thailand)