Prevalence of *Salmonella* spp. contamination in fresh chicken meat from slaughterhouses

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Abstract – **The prevalence of *Salmonella* contamination in fresh chicken meat was assessed from three slaughterhouses in Thailand, during January 2013 – December 2015. Among 2,304 meat samples, *Salmonella* - positive was 41.28%. The percentages of *Salmonella* contamination in fresh chicken meat were 47.59 % (365 out of 767 samples), 45.28 % (321 out of 709 samples) and 32 % (265 out of 828 samples) for Slaughterhouse A, B, and C respectively. *Salmonella* contamination was more likely to be detected about 37.80 - 50.49% in summer and rainy season (from March to October) than winter season. The slaughterhouse also influenced in either increase or decrease in *Salmonella* contamination of meats. The result reviewed that improvement of production process and requirement for strict hygienic standards could reduce *Salmonella* contamination in fresh chicken meat.**

Key Words – *Salmonella*, chicken, prevalence

I.   INTRODUCTION

Chicken meat is one of major protein sources and favorite for consumers around the world without religious restrictions. The chicken production, therefore, has a higher growing rate compared to other meats. The development of production technology and improvement of feed formulation and breeding have resulting in better feed conversion ratio (FCR) and shorter raising period. Thailand becomes the forth global exporter of chicken meat and products. After Thailand declared free Avian Influenza in 2009, European Union (EU) has imported raw chicken meat from Thailand since July 1, 2012.

According to the EU Regulation 2073/2005 [1], the food safety criteria for fresh poultry meat requires that *Salmonella* Enteritidis (SE) and *Salmonella* Typhimurium (ST) shall not be detected in 25 gram of sample, while, in the category of meat preparation such as salted chicken meat, all types of *Salmonella spp.* shall not be detected in 25 gram of sample. The EU rapid alert system has increasingly reported 3, 14 and 24 notifications/year of *Salmonella*-positive in chicken meat imported from Thailand since 2013. The loss in rejected consignments could approximately be estimated higher than 136 million baht. In addition, if the number of *Salmonella* contamination tends to increase. The EU shall implement stricter inspections or consider prohibit the import of raw chicken meat from Thailand.

Salmonellosis is among the most frequently reported foodborne diseases worldwide. In the United States, non-typhoidal *Salmonella* has been annually reported about 1 million cases and 19,336 hospitalizations [2,3]. In European, about two hundred thousand salmonellosises were confirmed during 2009-2010. [4, 5]. For Southeast Asia, approximate 22.8 million cases/year were unofficially estimated [6]. This pathogen could generally be found in various raw and processed foods such as beef, pork. However, one of the major potential food transmission vehicles of this pathogen is commercial chicken meat [7].

Salmonella could be contaminated at all production stages of chicken meat starting from farm, slaughterhouse, transportation and distribution [8]. Risk of contamination occurs at farm level beginning from chick receiving, raising, transporting to the slaughterhouse [9]. In addition, there is still a risk of contamination at slaughterhouse processing for examples, scalding, de-feathering, evisceration, carcass washing, and chilling, etc. [9, 10] *Salmonella* continues to be a challenge of poultry industry because chicken itself is original source of *Salmonella*. So there is a high possibility of *Salmonella* contamination at farm level even the farm has good bio-security

system or has been accredited for Good Agricultural Practice (GAP) [11]. Therefore, the present study was to identify prevalence level of *Salmonella* contamination and factors affecting the prevalence of *Salmonella* in fresh chicken meats.

II. MATERIALS AND METHODS

A. Sample collection
A total of 2,304 fresh boneless thigh and drum chicken meats were collected from three chicken slaughterhouses. These slaughterhouses are located in Chonburi, Suphanburi and Ubon Ratchathani provinces which each plant has a facility over 50,000 birds/day. Each plant was daily collected samples from January 2013 to December 2015. All samples were aseptically collected in sterile plastic bag and immediately transported in a cool box to the laboratory.

B. Isolation and identification of Salmonella
Salmonella were isolated according to a standard method of ISO 6579:2002 [12]. The typical colony was cultured on nutrient agar at 37 $\pm$1 ^{0}C for 24 $\pm$3 h and subjected to biochemical test to confirm *Salmonella* spp.

C. Data analysis
The percentage of *Salmonella* contamination in chickens were calculated. All results were analyzed using statistical software. CRD model was used to evaluate the differences in each month of *Salmonella* contamination. Probability (P) $\leq$ 0.05 indicates significance.

III. RESULTS AND DISCUSSION

Positive results of *Salmonella spp.* were detected in 951 samples out of 2,304 samples of fresh chicken meat, accounting 41.28 % of total samples. This result showed a much higher than the result obtained from Mathayompong who reported that the total *Salmonella* contamination carcasses were found in 1,556 out of 7,572 samples (21%) [11].

Figure 1 shows the average prevalence of *Salmonella spp*. (%) in fresh chicken meat during January 2013 to December 2015. The percentage of *Salmonella* contamination varied in each month but there were insignificant difference (p>0.05).

However, the percentage of *Salmonella* contamination was more likely to be higher during summer and rainy season (March to October) than other seasons in Thailand. It may attribute to optimum growth temperature (35-43°C) which promote the growth of *Salmonella* resulting on the higher prevalence. This finding is also in consistent with the report of CDC [13] which showed the highest prevalence of *Salmonella* infections (6-14%) in almost same period (May to November).
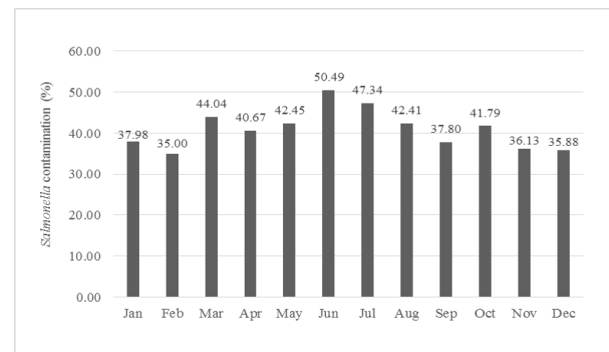

Figure 1. The average percentage of the prevalence of *Salmonella* in fresh chicken meat during January 2013 to December 2015

Several factors influence on *Salmonella* contamination including source of live birds (broiler farm) and cross-contamination during processing at slaughterhouse such as contamination between birds or carcasses, contamination from equipment, personnel, water and ice, etc. [10]. In addition, the number of this bacteria could increase due to improper controls of temperature during cutting, handling and storage [10]. When considering the influence of slaughterhouses, the result is shown in Figure 2. The average percentage of *Salmonella* contamination in plant A (47.57%) and B (45.28%) were higher than that in plant C (32%). This finding indicated the better performance of plant C in order to control the contamination. More details will be further explained.

In contrast, when considering the percentage of *Salmonella* contamination in each year, we found that the contamination of plant A tended to decrease. In contrast to plant C, the trend of contamination increased. The sudden decrease in the number of contamination in plant A attributed

to implement a new improvement of Standard Operation Procedure (SOP) program for the entire production process. The most effective improvement in plant A was the installation an additional chiller to its immersion chilling system making a total of 3 chillers in 2015. The effective cooling system prevent the growth of *Salmonella* in cooled water and also reduce a cooling time per unit. The *Salmonella* contamination was consequently reduced from 53 to 31%. The proper immersion chiller could inhibit a number of bacteria in poultry carcass, on the other hand, cooled water in this equipment could also be a major contamination source. Factors affecting *Salmonella* contamination in chiller are an initial number of bacteria on carcass before entering chiller, carcass temperature, over flow rate per carcass, the ratio of water use per carcass in chiller [8, 10]. Therefore, it is necessary for slaughterhouse to strictly control all these factors to prevent post contamination.
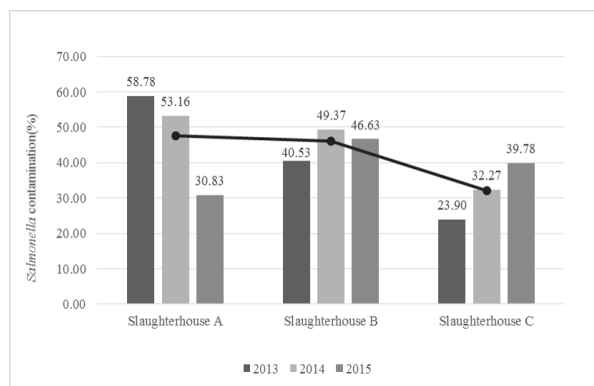

Figure 2. The average percentage of *Salmonella* contamination in fresh chicken meat from three slaughterhouses

Table 1 shows the month capacity of three slaughterhouses. Surprisingly, the relationship between the prevalence and production capacity seem to be unreliable. The slaughterhouse A increased its operation capacity from 130,000 to 145,000 birds/day. The average percentage of *Salmonella* decreased from 59 to 31%. On the other hand, slaughterhouse C decreased its capacity from 69,000 to 66,000 birds/day but the *Salmonella* contamination increased from 24 to 40%. This results indicated that the production capacity may not be a major factor for the

Salmonella contamination and it might be other interaction factors involved.

Table 1 The average percentage of *Salmonella* contamination in fresh chicken meat by slaughtering capacity per day

Slaughterhouse	Year	Capacity (bird/day)	*Salmonella* contamination (%)
A	2013	130,000	59
	2014	140,000	53
	2015	145,000	31
B	2013	80,000	41
	2014	67,500	49
	2015	72,500	47
C	2013	69,000	24
	2014	67,000	32
	2015	66,000	40

After gathering the information from all slaughterhouses, we found that when plant A increased the capacity, the new process control was applied. They added another chiller into the production line and increased higher water flow rate at scalding and chilling as well as applied strictly in the good hygiene practices. After chilling, the temperature of the meat is strictly maintained $\leq 4°C$ at all time during cutting, boning, trimming, slicing, wrapping and packaging. These implements resulted in a reduction of *Salmonella* contamination on carcass. Our results could be explained that when sanitation managements, especially good hygiene practice are more strictly implemented, *Salmonella* contamination could be reduced. Cleansing and disinfection are necessary procedures to eliminate and reduce pathogenic bacteria in the processing plant. *Salmonella* could adheres on tools and equipment and also colonize on equipment surfaces that contain meat residue [10]. In addition, on-farm interventions have the greatest impact on reducing *Salmonella* [14].

IV. CONCLUSION

The present investigation revealed the prevalence of *Salmonella* contamination in fresh chicken meat during 2013-2015. High level of *Salmonella* contamination is likely to be detected during the summer and rainy season. The slaughterhouse affect on the *Salmonella* contamination. These results suggest each slaughterhouse require to improve the efficiency of production process or to

strengthen implementation of their specific control procedures to decrease contamination of fresh chicken meat.

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