5. DISCUSSION AND CONCLUSIONS

5.1 Discussion

5.1.1 The aim of the study

It was the aim of this study to get a picture of *Salmonella* from highly populated urban/ suburban areas of South East Asia, where overlapping production/ stocking of animals as well as consumption would be observed. Here, data on the prevalence of salmonellae in chicken meat ready for selling was obtained from popular markets. In the different districts, a different pattern was obtained, possibly reflecting a different origin of the birds and the products.

5.1.2. Aspects of sampling

There were 262 samples taken from 16 markets in 5 districts of the capital of Hanoi. A total of 62 shops were visited, offering pieces for sale according to the convenience of the customers. During sampling, the samples were kept in plastic bags. The samples were investigated for their presence (presence/ absence test). A quantitative result was not intended.

5.1.3 Level of contamination

In this study, the prevalence of *Salmonella* in chicken meat from retail markets in Hanoi was 48.9%. The results are comparable to the findings reported in the US (Bokanyi, 1990) with 43% of broiler carcasses being contaminated with *Salmonella* or with results from Spain with 60% (Carraminana *et al.*, 1997) or Portugal (Antunes, 2003), 36% in Malaysia (Rusul *et al.*, 1996) and 34% in Belgium (Uyttendaele *et al.*, 1999).

However, in studies from other countries, the prevalence of *Salmonella* in chicken meat was lower than here: 8% in Albania (Beli *et al.*, 2001), 25% in the UK (Jorgensen *et al.*, 2002), 26% in Ireland (Duffy *et al.*, 1999), 16.4% in Austria (Mayrhofer *et al.*, 2004), 15% Denmark (Bager, 2000), 5.7% in UK (Food standard agency, 2001). Moreover, this study shows a lower prevalence of *Salmonella* in chicken meat when compared with countries such as Thailand with 72% (Boonmar, 1998) and Greece with 69% (Arvanitidou *et al.*, 1998).

For Vietnam, there are only a few reports on the prevalence of *Salmonella* in chicken meat. A study from the south part of Vietnam shows that 21% of the chicken meat samples were positive with *Salmonella* (Phan *et al*., 2005).

5.1.4 The Districts, Markets and Shops

In samples of one of the shops visited (District 4), no *Salmonella* was found, and at one of the shops visited (District 2), 100% of the samples were *Salmonella* positive. The high percentage of positive samples in some markets confirms the major role of salmonellae in poultry products, which had been expected from the production and marketing patterns in these markets.

However, there is still a difference: from District 4, a uniform pattern was obtained (*S.* Agona), which should be scrutinized more thoroughly. Possibly, the results reflect the same origin of the raw material or a sort of “market flora”. Also, the percentage of positive samples was quite different: in District 2, the highest percentage (62.5 %) and District 4, the lowest percentage (37.5 %) was obtained. The hygienic status of the shops promotes the transfer of salmonellae, once they are in or on the birds.

All of *Salmonella* Typhimurium (10 isolates) have been found in District 1 during winter time. On the other hand, some serotypes were common in the spring time - *S.* Agona. *S.* Emek or *S.* London could not be found during the winter time.

5.1.5 The serotypes

Mainly *S.* Agona (group B), *S.* Emek (group C), *S.* London (group E), and *S.* Typhimurium (group B) were obtained. *S.* Agona (31%) has been obtained most frequently in this study. In a similar study, Phan *et al.*, (2005) collected samples from different species from markets in the Mekong Delta, Vietnam. Predominant serotypes were *S.* Weltevreden (group E), *S.* Derby (group B), *S.* London (group E), *S.* Lexington (group E) and *S.* Tennessee (group C). Isolates from chicken meat were more broadly distributed, in this study among them *S.* Emek (group C), *S.* Typhimurium (group B) and *S.* Dessau (group E).

Data from the EU clearly show a different pattern of *Salmonella* serotypes: From the Zoonoses Report (EC, 2005), the range of predominant serotypes was *S.* Enteritidis (group D), *S.* Typhimurium (group B), *S.* Saintpaul (group B), and *S.* Heidelberg (group B). Also, in the EU, a higher proportion of group D types were obtained.

Salmonella Enteritidis (SE) and *Salmonella* Typhimurium (ST) are known as the most important non-typhoidal salmonellae associated with chicken meat and eggs (Taunay *et al.*, 1996). Many studies indicate a high prevalence of *S.* Enteritidis: 44% in Portugal (Antunes, 2003), 28% in Thailand (Boonmar, 1998), 54.35% in Austria (Mayrhofer *et al.*, 2004). But, in this study, *S.* Enteritidis was isolated only is 1.55% of isolates.

In Germany, the sero- pattern is different from the data obtained here; much more of Group D (*S.* Enteritidis 58%) was isolated, followed by Group B (*S.* Typhimurium 28%) (SIFIN, 2000).

From the different seropattems, it is concluded that serovares from chicken for international trade should be investigated in order to get a picture of upcoming global strains.

5.1.6 Geographic and local aspects

In the northern part of Vietnam, there are four seasons (summer, winter, spring and autumn). In the winter time, the temperature is low, cold and humid; during the first sampling from December, 2004 to January, 2005, the temperature was at a range 13-18^{0}C. The second sampling (spring time) from March to April 2005, the temperature was at 20-25^{0}C. The proportion of *Salmonella* contaminated in winter time was lower (41.43%) than in spring time (51.56%). However, the different contaminated proportion was not significant.

At present, there is no modern chicken processing line in Hanoi yet. Most of the poultry is slaughtered by the retailer. Others would be slaughtered in some wholesale chicken market. This might explain why the prevalence of *Salmonella* contamination in chicken meat in Hanoi is high.

5.1.7 Risk factor

The results from the questionnaire show that several factors can be considered risk factors, which increase the risk of presence of *Salmonella,,* such as chicken source, hygiene status, and shop surfaces. This study indicates that the “number of knives used”, “number of choppers used”, “hygiene status of shop” and “type of table surface” were significant risk factors of *Salmonella* contamination in chicken. Odds ratios showed the strong relation of exposure and a presence of *Salmonella.*

Distribution and trade patterns on the markets support the spread of salmonellae from the place of origin via markets to the consumers.

Finally, the high percentage of positive samples in some markets in an urban area in Vietnam confirms the major role of salmonellae in poultry products, which was to be expected from the production and marketing patterns on these markets.

5.2 Conclusions

262 samples from chicken meat in Hanoi, Vietnam were investigated for salmonella. The contamination rate of *Salmonella* was 48.9%. Season, district and market were not significantly associated with contamination of the poultry meat.

The main somatic group pattern was B (43 %), C (28 %) and E (26 %), predominant serotypes were *S.* Agona, S. Emek, *S.* London.

The proportions of *S.* Enteritidis and *S.* Typhimurium contamination were low 1.55% and 7.75%, respectively.

Some handling pattern ("Number of knives used", "Number of choppers used") as well as several aspects ("Hygiene status of shop" and "Type of table surface") were significant risk factors of *Salmonella* contamination.

The time of data collection represented only a short duration, the sample size was small. So, the data cannot stand for the prevalence in the entire area of the capital of Hanoi. However, these data may reflect other areas in Hanoi as well.