

5. DISCUSSION AND CONCLUSION

Porcine cysticercosis and trichinellosis are crucial zoonotic problems in a country like Cambodia with high pork consumption. In a period of six months, a total of 62,400 pigs were slaughtered in 4 slaughterhouses in Phnom Penh/Cambodia. Out of these numbers of animals, 432 were randomly selected for this study. The following discussion of the obtained results summarizes as follows:

5.1 Investigation on porcine cysticercosis

This was the first prevalence study of *T. solium* cysticercosis in slaughter pigs in Cambodia. Thus, no published prevalence studies existed in Cambodia prior to this work, except a short review by Singh *et al.* (2002). Hence, the following discussion of the obtained results has been compared and contrasted with reports from other countries.

In Cambodia, lingual examination has been used to identify pigs having *T. solium* cysts. This is performed for purposes of eliminating infected pigs so as not to lose money due to carcass condemnation during meat inspection.

As shown in the result, it was found that the prevalence of porcine cysticercosis by breeds was 13.2 % in local pig carcasses examined by ante-mortem inspection. This prevalence increased to 21% in the pig carcasses by meat inspection. On the other hand, the total distribution of prevalence for porcine cysticercosis in this study (n=432) was 6.7% by tongue palpation and 10.9 % by meat inspection. These findings agree with observations of a review by Singh *et al.* (2002) from Cambodia and different neighboring countries: 10% in Cambodia, 10% in Laos, 11% in Thailand and 8% in Vietnam. However, none of the pig carcasses from intensive production farms was found positive.

In the slaughterhouse study, the two methods were used, tongue palpation and meat inspection: The results differ from 6.7% by lingual examination and 10.9 % by meat inspection and result was determined by Kappa statistic. However, a sensitivity of lingual examination was about 62% to detect porcine cysticercosis, found by meat inspection. Thus tongue palpation is a very specific method to demonstrate cysticercosis in pigs, but it has a diagnostic sensitivity not exceeding 70%. These findings agree with some studies previously reported. In lightly infected pigs, both the sensitivity and the specificity are low (Sciutto *et al.*, 1998; Boa *et al.*, 2002). The study in Nigeria found that lingual examination could detect 14.9% of truly infected pigs (Onah and Chiejina, 1995), while in Peru, Gonzalez and others found that 70% of the infected pigs were detected by lingual examination (Gonzalez *et al.*, 1994). Dorny (2004) reported that the routine carcass inspection was slightly better than tongue inspection in detecting moderate to heavy infections, but was equally insensitive in light infections. Nevertheless, lingual examination is a relatively quick and inexpensive way of doing a rapid assessment of the presence and burden of porcine cysticercosis. Pig traders in the district of Cambodia have been using the lingual examination method to reject pigs that are recognized to have *T. solium* larvae under the tongue for fear of losing money due to carcass condemnation during meat inspection.

Knowing the predilection sites, *i.e.*, organs, which harbor a large number of cysticerci helps to increase diagnostic efficacy. The organs where cysticerci were mostly found infected in a higher degree were: the skeleton muscles as hindlimb, forelimb, masseters and in a lower degree were: heart, tongue, esophagus, diaphragm and rarely brain. Organs in which cysticerci were not detected include liver, lungs, spleen, kidney and intestine. Thus, infected organs vary depending on the degree of infection. These findings agree with some studies previously reported. For examples, Mendez *et al.* (1986) found the predilection sites to be forelimb above the elbows (pork shoulder), tongue and heart. Similar findings made by Onah and Chiejina, (1995) and Boa *et al.* (2002) who found the masseters and triceps muscles to be predilection sites. Liver, lung, spleen, kidney and intestine were not infected. However, Ma *et al.* (1992) found cysticerci of *T. solium* from lungs, kidneys and

livers of pigs in China and they differentiated from other *Taenia* species by the morphology of the hooks. These contrasting results may be due to species differences of *Taenia* and/or pigs from Africa and Asia, which could affect the host–parasite relationship. Also, it might be due to infection by *T. asiatica* found only in Asia, which has predilection in the liver.

Types of farm management are important factors, which may influence the infection rate. The prevalence of porcine cysticercosis in outdoor-reared types was 16.05 % (tongue palpation) and 25.54 % (meat inspection), while in the mixed-raised type found positive cases of 8.43 % (tongue palpation) and 14.45 % (meat inspection) were found. None of the pigs reared indoors or on intensive production farms was infected. These findings indicated that farm types have an influence on the infection rates of porcine cysticercosis.

Concerning the districts where pigs were reared, positive animals were from 19 out of 29 districts. By ante-mortem examination, prevalence ranged from 7.69 % to 50 % in 19 districts, while meat inspection showed prevalence of 9 % to 50 %. The findings are comparable to those reported in different areas of countries as China (0.8-40 %), Mozambique (6.5-33.3 %), Tanzania (4.5-26.9%) and Latin America (4-38.9%), (Table 2, pp.36).

In this study, 235 cysts were randomly selected (5 cysts of the 47 positive carcasses) from tongue, esophagus, heart and muscles examined microscopically for the presence of armed scolices. When present, sizes of hooks were measured. All of the 235 scolices exhibited small and large hooks. Obviously, in this study cysts of *T. asiatica* were not found. This is in agreement with Morakote *et al.* (2000) who reported that adult worms recovered from infected villagers in Chiang Mai, Thailand, consist of only *T. saginata* and *T. solium*. These findings pose questions on the role of *T. asiatica* in Cambodia and Thailand. Further studies should be done on identifying species of the adult tapeworms obtained from local people in endemic areas of Cambodia.

5.2 Investigation on trichinellosis

Similar to the porcine cysticercosis study, the present survey of trichinellosis in pigs was the first done in Cambodia.

The present study was conducted in 4 slaughterhouses. 440 pig serum samples were examined for trichinellosis.

Sero-prevalence for trichinellosis of slaughter pigs by AB-ELISA and endpoint titration for confirmation of trichinellosis positives was conducted at CMU laboratories. Five specimens were sero-positive: two were outdoor-raised pigs, one pig was mixed-reared and two positives were from indoor-raised pigs. Beside 5 positives, 5 specimens gave doubtful results. An overall sero-prevalence of trichinellosis was of 1.13 %. Similar findings are reported from some studies that used similar test conditions. For example, sero-prevalences of trichinellosis were recoded up to 2.5% in Mexico (La Rosa *et al.*, 1998) and in China ranged between 0.021-7.3 % (Liu *et al.*, 2002). However, sero-prevalences of trichinellosis were found under 0.02% in Northern of Thailand (Takahashi *et al.*, 2000) as well as under 0.013 % in North America (Gamble, 2000). These contrasting results may be due to many risk factors such as poor farm management, feed contaminations, close contact with rodents and wild animals and other sources.

In this study, all sero-positives were found in the 3-different farm types. The positive rates were: 1.40% of outdoor-reared pigs, 1.21% of mixed raised and 0.92% of indoor-reared animals. The infection rates by farm management did not differ significantly. This is much in contrast to cysticercosis, which indoor pigs were not infected with. It is possible that some risk factors are different, especially the sources of infection, such as infected rodents and feedstuffs.

Some positives were found in some areas of Cambodia, even though the details about sources of infection are not included in the objective for study due to time

limitation. Generally, it can be explained with frequently roaming free-range pigs coming into contact with infected rodent carcasses, with contaminated pork, garbage, etc. Most farmers also feed pigs with swill feed and uncooked animal organs. All these factors were suspected to favor the occurrence of swine trichinellosis, and may lead to the outbreak of human trichinellosis. The high prevalence of trichinellosis in both humans and animals invariably leads to significant economic loss. The positivity of trichinellosis in pigs among provinces shows that there were no significant differences of sero-prevalence of trichinellosis.

The questionnaire surveys were performed on residents of provinces, slaughterhouse workers and hospital personnel around Phnom Penh. Out of 202 people interviewed, 70 people were conducted in four slaughterhouses and 132 in three provinces. Awareness of the *T. solium* disease condition was virtually absent. In districts of provinces, human carriers and epilepsy were not reported. Pig husbandry practices, sanitary conditions, hygienic control and slaughter processes are very poor. The infection of pigs could be found very easily, when compared with other diseases. Surveys of hospitals around Phnom Penh showed that the data on human cysticercosis were lacking. It can be concluded that the results from the questionnaire survey, together with those from the prevalence study, help to create a better understanding on the role of pig slaughtering and farming management systems on the parasite transmission and provide more information about epidemiological factors which is necessary for the health authorities to develop integrated measures for control and prevention of cysticercosis and trichinellosis in the near future.

5.3 Conclusion and recommendation

It can be concluded that the two parasitic zoonotic diseases like porcine cysticercosis and trichinellosis may pose major problems in some endemic districts of provinces in Cambodia. The present studies used for disease detection have greatly contributed to a better understanding of the prevalence and epidemiology of the

infection and also of the impact of these diseases related to pig production systems and human health.

In this study design, there were advantages and disadvantages. It is noted that this study obtained more clear and precise prevalence than the previous study (Singh, 2002). This is because of the detailed study design that was based on well-established sampling methods, sample size determination, and data collection methods as well as standardized laboratory techniques. However, time was the limiting factor of this cross-section design. For example there was not enough time to study isolation and identification of *Trichinella* species as well as potential risk factors.

For further study, better study designs e.g. cohort study are important in investigations applied to trichinellosis, using gold standard methods like digestion and PCR for isolation and identification of *Trichinella* species in Cambodia. This type of study design (cohort study) could enable researchers also to determine or identify risk factors associated with trichinellosis in Cambodia. Results from a study design would assist in planning and implementing cost-effective surveillance systems and strategic control/eradication programs.

It is recommended that the hygienic standard at the slaughterhouses in Cambodia must be improved with standard guidelines of meat inspection. Prevention, disease controls, disease surveillance, awareness and treatment or de-worming of human tapeworm carriers in endemic areas should be implemented, additionally; toilet facilities and pig husbandry practices should be improved, avoiding access of pigs to human feces in the rural areas.

Recent surveys showed that many people in the rural areas either ignore or are ignorant of the danger to which they expose themselves by eating infected meat. Most of them did not understand the association between the presence of cysticerci in the animal and the tapeworm infection in man. Thus the long-term strategy involves health education, modernization of pig farming, and rigorous inspection of pork in slaughterhouses, creation of hygienic and sanitary conditions in the community,

disease control measures and active epidemiological surveillance systems to identify tapeworm carriers and to activate potential eradication.

A recent study conducted in slaughterhouses found that the chance of detecting cysts of porcine cysticercosis in slaughter pigs is low under the current meat inspection regulations. However, due to the lack of well-organized meat inspection and the presence of illegal slaughtering, almost all infected carcasses are marketed and/or consumed. Usually, contaminated pig carcasses with cysticerci are sold at a decreased price. It can be also suggested that meat inspection is mandatory to all slaughterhouses and put into national law.

It is recommended that intensive national surveillance is essential for trichinellosis control in both domestic pigs and wild animals in Cambodia based on the OIE guideline. Consumers and producers of swine in endemic area should follow the recommendations of the International Commission on Trichinellosis for the control of *Trichinella* in domestic and wild animals intended for human consumption (Gamble *et al.*, 2000). Enforcement of effective measures for trichinellosis control in Cambodia is strongly required. The easiest measure would be to educate and inform the public, insisting on the need to cook pork meat thoroughly. Then it would be to organize a network of laboratories specifically responsible for *Trichinella* monitoring and control in animals in slaughterhouses, as well as to use gold standard methods as recently indicated by the International Commission on trichinellosis (*i.e.*, the digestion test and ELISA test which are ten or a hundred times more sensitive than microscopy). It would also be useful to collect samples from wild animals, to evaluate more precisely the areas where intense control should be applied.