

## **1. INTRODUCTION AND OBJECTIVES**

### **1.1 General overview**

Nepal is a landlocked country situated in the lap of the Himalayas bordering with China in the North and India in the South, East and West. Nepal is located between the latitude of 26°22' to 30°27' north and the longitude of 80°4' to 88°12' east. The elevation ranges from 90 to 8848 metres. The northern range of the country is covered with snow throughout the year where the highest peak of the world, the Mount Everest, stands. The middle range is captured by gorgeous mountains, high peaks, hills and valleys whereas the southern range is characterized by the gigantic plain of alluvial soil which consists of a dense forest area, wildlife reserves and conservation areas. The country exhibits tropical, mesothermal, microthermal, taiga and tundra types of climate. Nepal is divided, administratively, into 5 development regions and 75 districts, whereas geographically in 3 regions; Mountain, Hill and Plain, which accommodate 7.3, 44.3 and 48.4 percentage of the total population, respectively (CBS, 2004). The central development region has an area of 27 410 sq. km and consists of 19 districts.

The total population of the country is 25 million with an annual growth rate of 2.25% (ABPSD, 2006). The population density is 175 persons per sq. km and 65.6% of population are engaged in agriculture (ABPSD, 2006). Nepal is part of the list of the least developed countries where 42% of population lives below the poverty line (UN-OHRLLS, 2006). About 17% of the population in Nepal is undernourished (FAO, 2004). The total health expenditure per capita was US\$ 64 in 2003 (WHO, 2006). Agriculture is the major economic sector although it only occupies less than one fifth of the total area of the country (NPC, 2004). It contributes 39.48% to the total GDP (CBS, 2004).

## 1.2 The livestock sector in Nepal

A distinct pivoted role of the livestock is well established in the farming system of Nepal since it functions as a supplier of manure and high value animal protein (Karki and Ghimire, 2003). The livestock sector contributes 30% of the agricultural GDP (FAO, 2005). About 92% of the rural households benefit from this sector (CBS, 2004). Farmers with a small landholding of between 0.2 and 0.5 hectares land keep almost 25% of the livestock. People who have either no land or own less than 0.2 hectares possess about 11% of the livestock (FAO, 2005). The livestock population of the country, namely cattle, buffalo, goat, pig and fowl are (in million) 7.0, 4.2, 7.4, 0.9 and 23.2 respectively (ABPSD, 2006). The annual growth rate is 1.12% in cattle, 1.93% in buffalo, 2.03% in goat, 4.55% in pig and 4.7% in poultry (Karki and Ghimire, 2003).

## 1.3 Pig farming and pig breeds in Nepal

Pig rearing is one of the most important means for food security and poverty alleviation in Nepal. The pig production in Nepal concentrates in the hill zones (mostly in the eastern hills) because the resident ethnic groups (Rai, Limbu, Magar, Tamang, Gurung and Tharu) have no reservations to keep and eat pork. In recent years, however, the caste system has become more relaxed and the consumption of pork in the higher caste has increased. That makes a 140% increase in the pig population in two decades (Joshi *et al.*, 2003).

There was a 5.2% annual growth rate in the pig production, which is the highest among the South Asian countries, in-between 1992-2002 (FAO, 2003). The pig population is 58% in the mid hills, 11% in the mountains and 31% in the plain territories (Sharma, 2003). Out of total pig population of 960 827 the administrative regions eastern, central, western, mid-western and far-western proportionate 50%, respectively 18%, 12%, 15% and 5% (ABPSD, 2006). The agriculture households with pig husbandry in the urban and the rural area are 6.4% respectively 12.1% (NPC, 2004).

The exotic breeds Hampshire, Landrace, Tamworth, Saddleback and Fauyen, are introduced in Nepal with a view to upgrade native swine. Bampudke, Chwanche and Hurra are the main indigenous breeds of Nepal (Shaha and Joshi, 2003). Bampudke pigs are found in lower hills, Chwanche in the middle mountains and Hurra pigs are in the plain territories. The pigs are reared here in both the scavenging and the intensive system. In the scavenging system both indigenous and improved pigs are allowed to roam, freely, around road sides and open areas and looking for available food. Therefore it is likely that they suffer from internal parasitic infection and other disease problems. It is estimated that 58% of the pigs are Chwanche, 23% Hurra and 19% are improved breeds. The scavenging rearing system is the preferred husbandry practices (Dhaubhadel, 1992). The common practices of feeding offal and kitchen waste in the backyards to the pigs contributes to the transmission of parasitic diseases in Nepal (Joshi *et al.*, 2005).

#### **1.4 Meat production, inspection, marketing and consumption in Nepal**

The meat production in Nepal is largely based on the smallholder subsistence production system except for some recently developed units of commercial poultry and pigs in some few pockets of the country (Joshi and Shaha, 2003). The net meat production amount is 219 205 metric tons and the contribution (’000) of buffalo, goat, pig and chicken is 142, 42, 15 and 15 metric tons, respectively (ABPSD, 2006). However, the meat production has increased in Nepal from the past decade but the average annual growth rate has still fallen behind the neighboring countries, except for pork that was previously at a very low level (TLDP, 2002). In Nepal 52.4% of the total pigs are slaughtered per year. The average carcass weight per pig is 31.8 kg (FAO, 2005).

There are evidences that the existing poor conditions in the slaughter facilities and the meat handling in Nepal contribute to the spread of zoonotic diseases (Joshi *et al.*, 2001). The Department of Livestock Services, the Department of Food and Agriculture Marketing and the Central Food Research Laboratories are indirectly related to the control of the animal slaughtering for the market. Due to a lack of implementation of the ‘Animal Slaughterhouse and Meat Inspection Act-1999’, there

is a reluctant absence of meat inspection in Nepal. Because of this legislative problem the meat from sick or parasite-infected animals is serving as a main source of infection to humans as well as to other animals (Joshi *et al.*, 2003).

The marketing of pork tends to be organized, informally, for the local consumption but it is much more organized for animals destined for urban centers like Kathmandu and Pokhara where the demand for pork is increasing, significantly (TLDP, 2003). The import of livestock products accounts for 1.1% of the total import, the export constitutes of 0.2% of the total export while the net pork import is 0.23% of the total consumption (FAO, 2005).

The actual consumption of meat and meat products in the country is influenced by religious, cultural and economic factors. In Nepal only 2% of the people are vegetarian. Most consume meat with their staple diet of rice and lentils. The imported live animals from India, rather than the local supply, meet much of the urban demands for the consumption. The average per capita daily food intake by the Nepalese population is 2264 kilocalories. 160 kilocalories of that are obtained from different animal products (EarthTrends, 2003). Pork occupies 7% (5626 metric tons, annually) of the total meat consumption in the country. That is the second highest amount after the buffalo meat consumption (ABPSD, 2006). The general meat consumption is highest in-between August-November since it coincides with the Hindu festivals. Pork, however, mostly get consumed during the winter months. In Nepal the consumption of pork through the practice of low heat barbecuing is becoming more popular. That will substantially increase the meat borne parasitic zoonoses problems (Joshi *et al.*, 2005).

### 1.5 *Trichinella* and trichinellosis

Roundworms of the genus *Trichinella* are spread worldwide. They are responsible for one of the most serious helminthic zoonoses. The *Trichinella* nematode is one of the biggest intracellular parasites (Despommier, 1990). In nature it is maintained by sylvatic and domestic cycles (Pozio, 2000a). The domestic cycle includes domestic pigs which may become infected by the consumption of rodents, by

tail biting, by swills or carcasses of wildlife, foxes etc., by carnivorism and cannibalism (SCVPH, 1998).

The global prevalence of the disease trichinellosis is unknown, but estimates indicate that 11 million peoples might be infected (Wang *et al.*, 2006). The International Commission on Trichinellosis (ICT) has reported more than 10 000 cases of human trichinellosis (1995-1997) and it has been regarded as a re-emerging disease (Dupouy-Camet, 2000). The most common source of human infection worldwide is pork, wild boar and other game meat. However horse, dog and many other animal meats have also served as sources of infection (Dupouy-Camet, 2000). The epidemiological data on *Trichinella* infection in pigs show that this infection is usually confined to small farms with traditional pig rearing practices or grazing in wild areas (Pozio, 2000a).

The trichinellosis is still not under control in many parts of the world, because of the evolution in the food habits of people, new sources of infection other than pork, increase in international trade and tourism (van Knapen, 1997). It is recognized that in many parts of the world none of the existing methods of control for *Trichinella* infection are applied because of the economic problems, erosions of veterinary infrastructures, failure of educational systems, ineffective abattoir control measures and non-awareness of the disease by medicals. These factors are responsible for *Trichinella* infection still in the food chain in large parts of the world (van Knapen, 2000; Murrell and Pozio, 2000).

## 1.6 Statement of problem

Trichinellosis has been recognized over the past decades in many parts of the world in new hosts and with new epidemiological contexts (Pozio, 2000a, Pozio *et al.*, 2002). The practice of low heat barbecuing is popular among Nepalese. The certain ethnic groups in eastern region are mainly consuming raw pork in their regular dishes. Sporadic suspicions of trichinellosis in humans have been reported by different medical hospitals in Nepal. However there is no confirmation (Joshi *et al.*, 2005). The



pig meat inspection is non-existent in Nepal. So a hypothesis of a high number of human cases is assumed.

Nepal is in the stage of implementing the animal slaughterhouse and meat inspection act. In such aspect, the identification of zoonosis related problems in the country is important and should be brought to the attention of veterinary and public health authorities. The species differentiation of *Trichinella* has not been done yet and the source of *Trichinella* infection either domestic and/or sylvatic in pigs is unknown to the country.

### 1.7 Scientific justification of the study

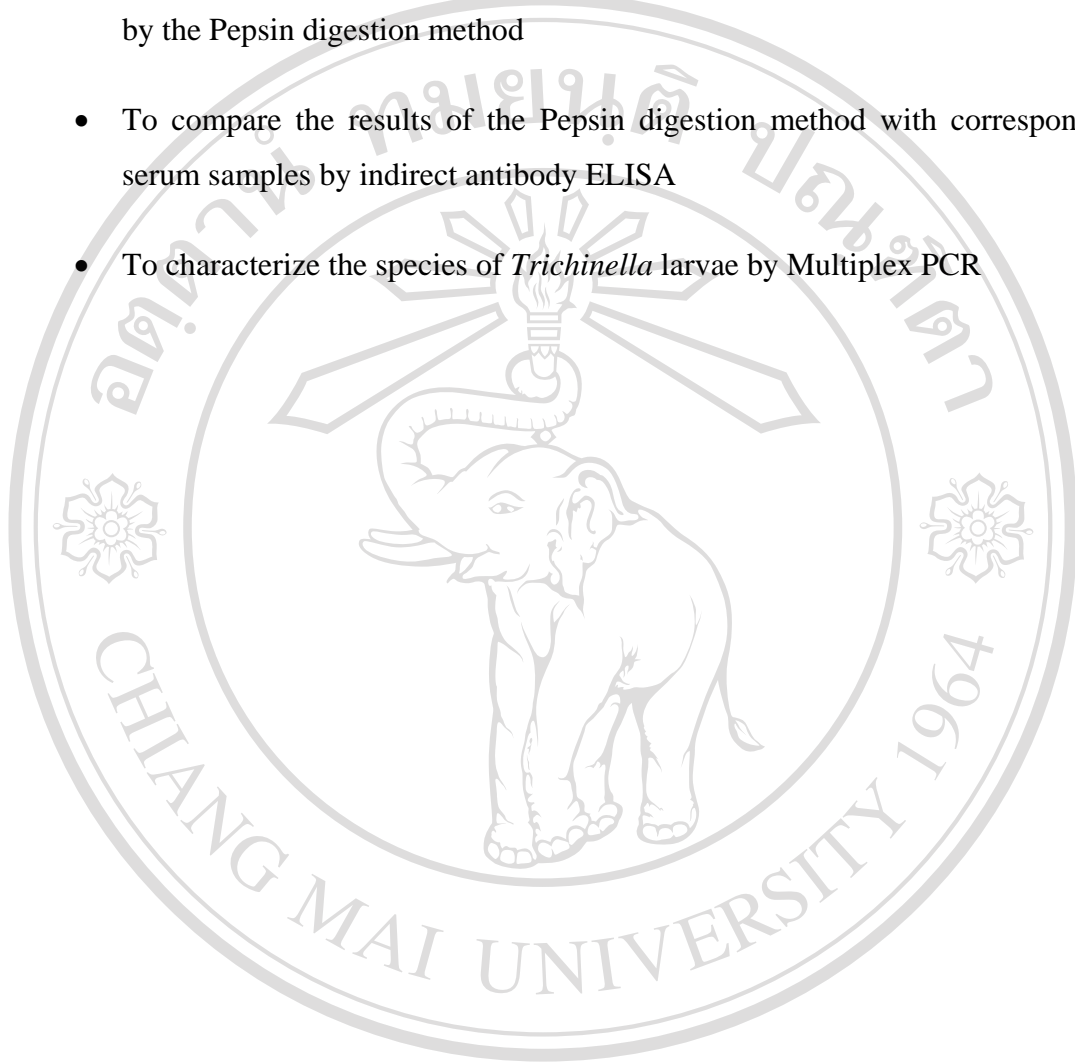
Joshi *et al.* (2005) have reported a prevalence of 0.47% with western blot and Sapkota *et al.* (2006) have reported a prevalence of 1% with antibody ELISA on pig's sera in Kathmandu, Nepal. Both studies suggest serological evidence of trichinellosis.

In pigs high antibody titers against *Trichinella* reveal a recent infection because several months after the infection the antibody level begins to decrease. Therefore doubtful titers are not predictive enough in older animals. So a verification of a realistic prevalence of parasites is required by using a Pepsin digestion method. Concerning the countrywide control of trichinellosis it is important to compare the results of the serology with the Pepsin digestion method. According to the Directives 64/433/EEC and 77/96/EEC a routine slaughter inspection for *Trichinella* by pooled sample digestion is required in all member states of the European Union for the trade between the member countries as well as for pork imported from third world countries (Nöckler *et al.*, 2000).

Preventing *Trichinella* infections in domestic animals requires information about local epidemiological factors. In addition the species of *Trichinella* should be identified. So the relevant economic proposal on its control can be developed as a baseline comparison for future interventions. In this study the *Trichinella* infection in slaughtered pigs of the central development region of Nepal was examined from an epidemiological perspective.

### 1.8 Objectives of the study

- To investigate the *Trichinella* larval status in meat samples of slaughtered pigs by the Pepsin digestion method
- To compare the results of the Pepsin digestion method with corresponding serum samples by indirect antibody ELISA
- To characterize the species of *Trichinella* larvae by Multiplex PCR



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