1. INTRODUCTION AND OBJECTIVES

1.1 Background and statement of the problem

Vietnam is one of the developing countries in South-East Asia where the majority of the population is involved in agriculture farming. Out of a total population of 83.1 million 73 % live in the rural areas (GSO, 2006). With the advantages of the changing mechanisms from a centrally planned economy to a market-oriented system, Vietnam has been able to manage to reach not only self sufficiency in the grain production since the 1990 but has also accomplished to produce a small surplus for the export of grain (ITPC, 2006). Since then, Vietnam's livestock sector annual growth rate has been increasing, rapidly (Dinh and Tran, 2001). The value of Vietnam's total livestock (except in 2004 because of the avian influenza crisis) increased from 4.2 % in 2001 to 11.6 % in 2005, accounted for 25.0 % of the agricultural gross domestic product (GDP) (GAIN, 2006). The major livestock in Vietnam is pig, poultry, cattle, horse and goat (USDA, 2005). The pig farming, however, has occupied a dominant role and it has contributed 81 % of the total animal meat production (GAIN, 2006). Meat consumption in Vietnam has increased in recent years (GAIN, 2006). According to the Ministry of Agriculture and Rural Development (MARD), Vietnam's annual per-capita meat consumption (live weight in kg) has increased from 31.3 to 35 in 2004/2005 (USDA, 2005). Hanoi has 3.145 millions of inhabitants and a big number of tourists and in-official immigrants (GSO, 2006) are residing there who consume around 190-210 tons of pork every day (CCTYHN, 2005).

In the process of food production many kinds of antimicrobials are used for preventing and controlling diseases, enhancing growth and increasing feed efficiency in food producing animals (CDC, 2005a). The use of antimicrobials in them can promote the emergence of resistance in micro-organism (Asai *et. al.*, 2005; Olofsson, 2006). Therefore the resistant bacteria can infect the humans via the food chain

(WHO, 2002a; Phillips *et al.*, 2004). Throughout the world the incidences of antimicrobial resistance have been increasing and in such aspect cross-resistance and multi-resistance patterns have been observed (WHO, 2002b). The emergence and the development of antimicrobial resistance in micro-organism with its scattering nature therefore turned into a global public health concern (WHO, 2007).

Many international organizations such as the Food and Agriculture Organization (FAO) and the Official International des Epizooties (OIE) have already given global recommendations for antimicrobial use in agriculture production (WHO, 2002a). In most countries there have been several studies in depth to address those issues relating to antimicrobial resistance (Schröder, 2004; Burch, 2005). Many developed countries have held active plans for monitoring of antimicrobial resistance in bacteria. Sweden has already established a special program that is banning antimicrobials as additive substances in feed for the purpose to increase growth since 1986. The establishment of the European Antimicrobial Resistance Surveillance System (EARSS) since 1999 is the new update, which has carried out extensive monitoring and surveillance of antimicrobial resistance within the whole European region (EARSS, 2006). Since January 2006 Europe as a whole has banned antimicrobials in feed for the purpose of improving animal growth, completely (Klotins, 2004). In such a way the inventory establishment of the National Antimicrobial Resistance Monitoring System (NARMS) in the United States of America (USA) has raised global awareness regarding the resistance of bacteria (CDC, 2005b).

In the Pacific and South Africa the SENTRY Antimicrobial Surveillance Program (SENTRY-ASP), which is a part of a global surveillance program on resistance, was established in 1997. This program was designed to monitor predominant pathogens and their antimicrobial resistance to 29 antimicrobial agents. The database has gained data which has been useful for finding antimicrobial patterns and trends of antimicrobial resistance in these countries (Bell and Turnidge, 2002). Within the Asian countries there have been several studies on this issue. Alhaj *et al.*

(2007) have described the distribution of antimicrobial resistance of *Escherichia coli (E. coli)* isolates from different sources (animal, food, marine, clinical and river) in Malaysia. The series of studies on resistance of bacteria isolates from food animals and humans in Thailand have been reported (Nirdnoy, 2005; Padungtod and Kaneene, 2006; Padungtod *et al.*, 2006).

In Vietnam most of the studies focus only on resistant bacteria in humans (Sullivan and Nguyen, 1971; Ha *et al.*, 1999; Bui, 2003) and studies on this issue in animal's food are generally lacking (Dinh *et al.*, 2003; Do *et al.*, 2003; To, 2006). However, a recent study on antimicrobial resistance of *E. coli* isolated from pork and chicken meat collected in the Red River Delta has found that *E. coli* was still sensitive to gentamicin and norfloxacin but resistant to chloramphenicol, tetracycline, doxycycline, ampicillin, sulphonamides, neomycin and ofloxacin (To, 2004, 2006). There are various kinds of antimicrobials used in food producing animals (Boisseau, 2002) but the antimicrobials tetracycline, oxytetracycline, doxycycline, trimethoprim, sulphonamides, streptomycin, neomycin, gentamicin, ampicillin, cephalothin, norfloxacin, orfloxacin are most commonly used (To, 2006).

E. coli is a contaminant bacterium on meat surfaces and can be an indicator for environmental fecal pollution by enteric pathogenic bacteria (Moldlab, 2002). *E. coli* has many advantageous characteristics such as safety in laboratory experiments, rapid growth, survival and growth in simple media in both aerobic and anaerobic conditions. Besides it possesses plasmids which play an important role in transferring genetic material between bacteria, including antimicrobial resistance genes (Sherley *et al.*, 2004). It has enhanced the interest of researchers for more detailed observations (Hoyle, 2001).

1.2 Significance of the study

This study was designed by using reliable and internationally recognized detection and cultivation methods to examine antimicrobial resistance of *E. coli*

isolates from retail fresh pork in Hanoi market. It has assumed to provide the more professionals details of *E. coli* as reference materials with respect to the local epidemiological situation. It also supports the uplifting of professional carriers and the improvement of Vietnam's food safety standard that will be a basis for future interventions for controlling the food safety hazards from animals and their products for human beings. In the global context the output of this study will be a guideline for establishing sound programs to limit the development of antimicrobial resistance in bacteria of piggery origin and to control the spread of antimicrobial resistance from pigs to human beings.

1.3 Objectives of the study

The objectives of this study are:

1) To find out the prevalence of antimicrobial resistance of *E. coli* isolated from the retail fresh pork in Hanoi market.
2) To find out the resistance patterns of *E. coli* to commonly used antimicrobials.
3) To find out the risk factors associated with antimicrobial resistance in *E. coli* isolated from pork.