CHAPTER I

INTRODUCTION AND AIMS

Growth of newborn piglets is depended upon the protein content of the sow's milk. Therefore, dietary management of the lactating sow ensuring a diet sufficient in protein is an important factor to achieve the ability of the sows to produce adequate milk to support the rapid growth of their litters. The main source of amino acids or protein of suckling piglets is found in sow's milk. Thus, diet of lactating sow need to be formulated to maximize milk production as well as to allow the sow to maintain body condition throughout lactation. Failure to meet the amino acid requirements of the sows during lactation can lead to decrease milk production and litter weaning weights (King et al., 1993). Furthermore, deficiency of amino acids such as arginine and valine in sow's milk can retard piglet growth (O'Quinn et al., 2002). The previous studies of Trottier et al. (1997) and Nielsen et al. (2002) reported that there were two different physiological mechanisms responsible for the appearance of amino acids in milk, namely mammary plasma flow and amino acid transport systems in mammary tissues. Figure 1.1 elucidates the relative factors affected on growth performance of piglets as rational flow chart.

The level of dietary protein concentration is an important factor that affects amino acid concentration in sow's milk via these two mechanisms (Guan et al., 2004a). As dietary crude protein (CP) increased from deficient protein (7.8% CP) to normal protein (18.2% CP) level, all essential amino acids taken up across mammary tissues were increased and reached maximum in sows fed with the normal protein diet (18.2% CP), and decreased in those fed with the excess CP diet. A quantity of amino acids taken up across mammary tissues can be calculated by multiplying the mammary arteriovenous difference concentration (AV-dif) by the daily mammary plasma flow. The mammary arteriovenous difference of amino acids indicates as amino acids which enter and leave the mammary glands (Trottier et al., 1995). However, that study showed that the mammary arteriovenous difference for amino aid concentration was increased with increasing dietary CP concentration while the mammary plasma flow was not change

(P>0.05). Consequently, the mechanisms responsible to directly increase the arteriovenous difference may possibly be through types of amino acid transport system, gene expressions of amino acid transporters, and localization of amino acid transporter gene expression. Therefore, these reasons indicate that the amino acid transport systems may play the important roles on amino acid transport for milk composition and for sow's milk production and then affect their piglet growth. Nevertheless, only a few studies have been undertaken on the amino acid transport systems in sow's mammary tissues.

The transportation of amino acids from mammary arterial plasma across mammary cells by amino acid transport systems is now recognized as an important mechanism of amino acid appearance in sow's milk. Amino acids, absorbed from the digestive system, do not permeate through cell membranes and therefore require specialized transport proteins in order to cross the cell membranes (Christensen, 1990). The lactating mammary gland takes up free amino acids from the blood in large quantities to satisfy the needs of protein synthesis (Guan et al., 2004a). These amino acids are used for synthesis of nonessential amino acids and mammary tissue protein which are oxidized in mammary cells (Trottier et al., 1997). At least five amino acid transport systems have been characterized to transport amino acids into the mammary secretory cells (Shennen, 1997). The amino acid transport systems have been classically characterized based on substrate specificity, ion dependence, and kinetic properties (Ganapathy et al., 1994). The important amino acid transport systems for sows and their piglets that should be studied are: system A that prefers to transport neutral amino acids, especially short-chain amino acids such as methionine (Baumrucker, 1985; Shennan et al., 1994; Sarah et al., 2005); system L, which is principally responsible for the transport of branched-chain amino acids that are taken up in excess of their appearance in milk (Baumrucker, 1985; Shennan et al., 1997; Jackson et al., 2000); system y^+ that transports cationic amino acids such as lysine that is the most important amino acid because it has been indicated as the first limiting amino acid in diets for lactating sows (Baumrucker, 1985; NRC, 1998) and also transports arginine that is the precursor for synthesis of proline (Ball et al., 1986), polyamine, nitric oxide,

and non-essential amino acids (O'Quinn et al., 2002); and system $B^{0,+}$, which functions as the exchanger for cationic and neutral amino acids (Sloan and Mager, 1999).

Currently, the requirements for sow milk production are based solely on the amino acid composition of secreted milk protein. It may inaccurately predict requirements (Nielsen et al., 2002). Therefore, the estimation of the amino acid requirements should be assessed using the amino acid uptake across mammary tissue because they consist of amino acids which are derived directly from blood, metabolized in mammary secretory cells, and deposited at amino acid pool of mammary secretory cells (Trottier et al., 1997). It is necessary to gain basic knowledge of the amino acid transport systems and perhaps use this knowledge to combine and to estimate the amino acid requirements at peak lactation in sows. However, most of the studies have been conducted on mice, rats, guinea pigs, cattle, goats, and humans. Only a research study by Laspiur et al. (2004) was conducted on mRNA expression of some amino acid transporter in lactating sows. In addition to extrapolation of the knowledge from the mammary glands of other species, it should not be directly applied to lactating sows.

Therefore, the first objectives of this study was to determine the mRNA expressions of amino acid transport systems; system L and heterodimer; LAT2, and 4F2hc, system A; ATA2, system $B^{0,+}$; $ATB^{0,+}$, and system y^+; CAT2B at peak lactation (d18 of lactation) in porcine mammary tissues. The second objective was to determine the effects of dietary protein on growth performance in piglet, plasma amino acid concentrations, physical and histological changes of mammary glands and tissues as well as the relative abundance of mRNA expressions of amino acid transporters in mammary tissues of sows fed with deficient protein diet (8.2% CP) compared to those fed with control diet (18.2% CP) at peak lactation (d18 of lactation).

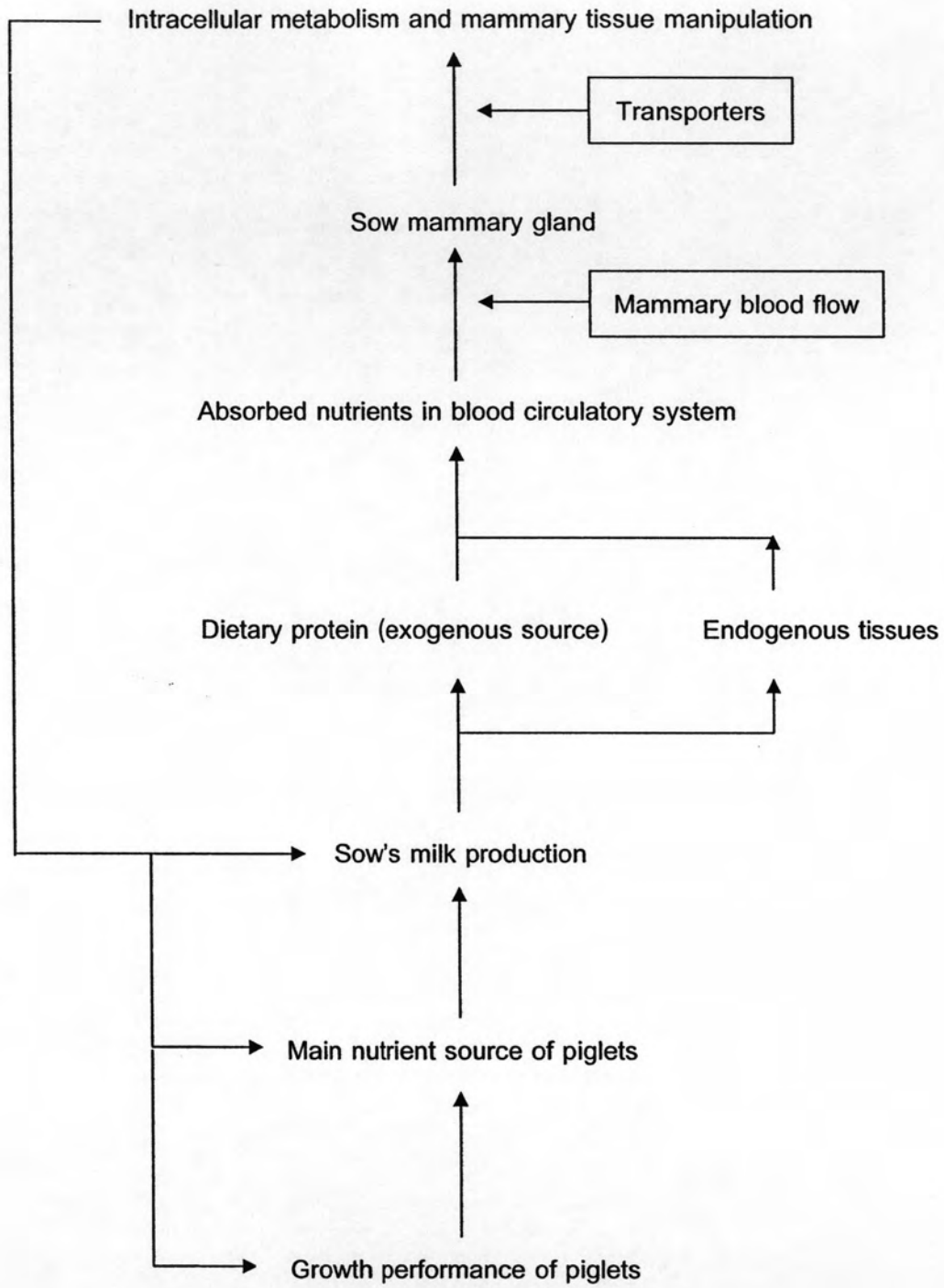

Figure 1.1 Rationale of the study. Growth performance of piglets was affected by sow's milk production. Milk production of sow depended on intracellular metabolism and functional cells in mammary tissues that responded by either mechanism of transporter or mammary plasma flow.