CHAPTER I

INTRODUCTION AND AIMS

Dairy industry in Thailand has been developed for over 40 years. One of the most important problems of dairy industry in the tropical area is the low milk production of exotic dairy cattle in comparison with animal in the temperate zone. Therefore, crossbred dairy cattle (*Bos taurus* x *Bos indicus*) have been used to overcome this problem. Eventhough crossbred animals have been used as an efficient tool for dairy farm in hot and humid climate of the tropical area, but the low milk production of both exotic and crossbred dairy cattle is still the main problem. One of the problems, which may limit milk production of dairy cattle in the tropical area. is an inadequate supply of forage during the summer. Animals are fed mainly on crop residues, such as rice straw, which has a low nutritive value. To overcome the livestock feed problems, several chemicals such as urea have been used to improve the feeding value of low quality roughage (Klopfenstein, 1978). However, few data are available concerning the utilization of chemical agent to manipulate ruminal fermentation pattern such as monensin supplement in crossbred dairy cattle fed on rice straw as a roughage.

It is known that high milk production in the early period of lactation is due to the present of the numerous active alveoli. The yield maintains for 3-4 months and then declines as lactation advance. The declination has been suggested to be due to the involution process of the mammary gland. In the lactating period, lactose is the main milk composition that exerts milk volume by an osmotic association (Kuhn et al., 1980). Many factors, both extrinsic and intrinsic that determine the activity of lactose synthesis under different conditions will intern affect milk volume. Lactose yield has

been suggested to be the main milk volume regulatory factor. The synthetic pathway of lactose depends on the numbers and the capacity of active mammocytes which are varied by the lactational stages and the hormonal status. The number and the capacity of active mammocyte are highest in the early lactation and abruptly decline when the process of gradual involution comes (Hurley, 1989). The capacity of individual mammary cell in both acute and adaptive responses would be the main factor that controls lactose synthesis in every stages of lactation. The possible regulating factors for the cell capacity are enzymes, co-factors and precursors involving in the synthetic pathway. Besides enzymes and co-factors which are not the rate-limiting factor in the pathway (Kronfeld, 1982), the availability of substrate, especially glucose is the only factor controlling the pathway.

Glucose accounts for 60-85% of milk lactose synthesis (Chaiyabutr et al.,1980). The relationship of milk yield and plasma glucose concentration has been shown to be linear when the plasma glucose concentration is below 3.0 mM. Raising the plasma glucose concentration above this level does not increase milk production (Kronfeld, 1982). The abomasal infusion of glucose which raises plasma glucose concentration from 65.9 mg/dl (3.7 mM) to 70.3 mg/dl (3.9 mM) has been shown to increase milk yield while the percentage of milk fat and protein decrease slightly. However, daily yield of milk fat and milk protein and plasma insulin are not significantly affected (Frobish and Danis, 1976). The plasma concentration of acetate, but not the plasma concentration of glucose or the mammary gland arteriovenous difference of acetate, has been shown to represent the determinant of the arteriovenous difference of glucose in the mammary gland (Miller et al., 1991a.b). The rate of lactose synthesis has been demonstrated to follow Michellis-Menten kinetics with a Km of 1.5 mM (Kuhn et al.,1980) which exceeds the glucose concentration within the cell. A steep concentration gradient of glucose across the plasma membrane, from 3.0

to 3.5 mM in plasma to 0.1 to 0.3 mM in the cell and the acetate concentration in plasma ranging from 0.5 to 1.5 mM are noted (Faulkner et al., 1981). The transport of glucose across the plasma membrane and glucose uptake which are related to the fluctuation of blood acetate concentration can be accounted for some of the lactose synthesis capacity.

In ruminant, rumen is an organ, which supplies nutrients to the other organs. Changing the pattern of ruminal fermentation may affect to the mammary gland for adaptive response in a new condition. Dietary and chemically manipulated ruminal fermentation patterns have been used to increase the milk production efficiency of the cow or to select an appropriate milk producing condition for the cow. Monensin, the carboxylic polyether ionophore, having molecular weight of 692 dalton, synthesing from bacteria (Haney and Hoehn, 1967) has been used in dairy cow for improving feed efficiency. Monensin has also been used as an antiketogenic and antibloat agent by its inhibitory effects on certain microorganisms (Bergen and Bates, 1984). The major effect of monensin has been shown to occur in both the pattern of volatile fatty acid and nitrogen productions (Schelling, 1984).

It has been shown that the cow treated with monensin and feeding on either high fiber dietary or high concentrated dietary sources show a tendency to increase in the net portal flux and portal-arterial difference of glucose whereas the net hepatic and the total splanchnic flux of glucose, L-lactate, β-hydroxybutyrate,acetate, propionate and butyrate are not affected (Harmon and Avery, 1987; Harmon et al., 1993). The arterial blood glucose concentration in the cow treated with monensin are not changed (Harmon and Avery, 1987; Sauer et al., 1989; Harmon et al., 1993; Hayes et al., 1996; Ramanzin et al., 1997) or increased (Abe et al., 1994). The other metabolites in the arterial blood are not consistently affected except the decrease in the level of plasma

β-hydroxybutyrate (Harmon and Avery, 1987; Sauer et al., 1989; Abe et al., 1994). An increase in milk yield has been apparently noted after treated with monensin in pastured cows (Lowe et al., 1990; Lean et al., 1994; Hayes et al., 1996). Milk yield of the most feedlot cows are not changed after monensin administation (Baile et al., 1982; Sauer et al., 1989; Abe et al., 1994; Ramanzin et al., 1997). In most of the experiments, the decrease in feed intake during monensin treatment has been apparent which means that monensin treated cows could increase milk production per amount of feed intake, However, the increases in the milk volume are inconsistent.

The glucogenic theory has been used to explain how monensin can elevate milk production. An increase in the plasma glucose concentration during monensin supplement should be a possible route to supply more glucose to the mammary cell. The plasma glucose concentration depends directly on the gluconeogenic capacity of the liver and the utilization of glucose by many organs. Since the main glucogenic substrate in the ruminant is propionate. An increase in the propionate concentration by the action of monensin would increase glucose availability to the mammary gland. This process has been used to explain the effect of monensin on milk production (Lowe et al., 1990; Lean et al., 1994; Hayes et al., 1996).

The milk production depends upon the quantity and quality of nutrients intake and their utilization at tissue level, including the type of forage fed to the animal. Since rice straw, which is considered one of the low quality rouphage with low energy production, is used to replace hay particularly as dairy cattle feed in dry season in Thailand. Therefore, the present study was conducted to obtain an information on whether monensin supplementation could be used as a potential dietary supplement for milk production in crossbred dairy cattle during feeding on rice straw. Mammary blood flow, mammary uptake of glucose, milk composition and ruminal fermentation

patterns were determined during late lactating period of crossbred dairy cows feeding on rice straw as a roughage in either control animals or monensin treated animals. The results should partly explain those previous controversial effects on the selection of monensin as a dietary supplement for milk production during late lactation in crossbred dairy cows.