# CHAPTER V

# DISCUSSION

In the present study, measurements of the mammary function of 87.5 % late lactating crossbred Holstein cows in response to exogenous administration of bST have been carried out.

In the bST-treated animal, milk yield increased after bST administration throughout the experimental period. The percentage of changes of milk yield in treatment group increased 5.51% on day 1 to 30.95% on day 16 (Figure 3). An increase in milk production in animals treated with bST coincided with an increase in mammary blood flow. It has been reported that milk yield of 87.5% crossbred Holstein cattle decreased rapidly coincided with the reduction of endogenous growth hormone and mammary blood flow (Chaiyabutr et al., 2000). In the present study, the increase in mammary blood flow in response to bST treatment was proportionally greater than an increase in milk production. These results indicate that bST exerts it effects in milk production by involving both extra-mammary factors and intra-mammary factors. The present data confirmed the finding that the galactopoietic effect of bST involves an increase in the synthetic capacity of the mammary gland (Nielson, 1988) since, late lactating animals were used in the present study and an involution of mammary epithelial cell might be involved in this period. The study by Sejrsen (1986) revealed that systemic administration of bST to growing heifers increased the proliferation of mammary growing tissues. Knight et al (1990) observed that the declined in mammary cell numbers that normally occurs during lactation advance was prevented in goats that received growth hormone. Bladwin and Knapp (1993) demonstrated that bST-treated cows

had increased protein synthetic capacity as indicated by an increased RNA per gland.

In the present study, treatment of late lactating cows with exogenous bST increased the plasma concentration of IGF-1, which associated with an increase in mammary blood flow. The present results confirmed the study in both cows and goats that the plasma IGF-1 level increased in response to growth hormone treatment. (Davis et al., 1988; Prosser et al., 1991b; Bauman and Vernon, 1993 and McGuire et al., 1994). An arterial infusion of IGF-1 into the mammary gland has also been shown to stimulate blood flow to the gland and increase milk production (Prosser et al., 1990). It is possible that bST exerts its effects indirectly by stimulation IGF production. It has been reported that IGF-1 may increase blood flow to the mammary gland and enhance transportation of milk precursors to the gland. It eventually alters the synthetic capacity of secretory cells and promotes persistence of lactation by slowing the rate of mammary involution (Burton et al., 1994). The first evidence implicating IGF-1 in bovine galactopoiesis included observations of chronically IGF-1 concentrations in blood and lactating mammary tissue during periods of bST administration (Glimm et al., 1988). In addition, IGF-1 mRNA has been found in lactating mammary tissue, and its abundance has been altered as a result of bST treatment (Glimm et al., 1992). In the present study, an increase in the ratio of mammary blood flow to milk yield correlated with rapid increase in mammary blood flow after bST injection. An increase of mammary blood flow in response to bST treatment coincided with an increase in IGF-1 level in plasma. Milk yield slightly increased and significant increase on day 8 to day 20 of the experiment. The present result suggests that IGF-1 in plasma may affect mammary tissue to slow down rate of involution of cell, increases the persistency of lactation, causing higher levels of milk production to be maintained for a longer period of time.

Although liver is the major source of IGF-1 in blood, IGF-1 is produced in other organs and tissues, and it exerts autocrine, paracrine and endocrine effects on

target cells (Gluckman et al., 1987). IGF-1 may play an endocrine role in mediating galactopoietic effects of exogenous bST during late lactation. Sharma et al. (1994) reported that the parallel changes in serum IGF-1 and hepatic IGF-1 mRNA indicating exogenous bST increases IGF-1 synthesis in the liver of cows during late lactation. Its origin appears to be the circulation but increased concentrations of radiolabelled IGF-1 in the local environment of individual mammary glands being reflected in an increased concentration in milk from that gland has been noted (Prosser et al., 1991a). In addition, increases in concentrations of IGF-1 in milk appear to correlate with an increase in the level in mammary secretory tissue (Prosser et al., 1991b). The circulating level of IGF-1 has been reported to be major importance in promoting increased milk production, since an increase in milk yield correlated with changing levels of IGF-1 in plasma than in milk has been reported (Faulkner, 1999). Effects of IGF-1 in local vessels of the mammary gland have been demonstrated to relate on mammary blood flow (Prosser et al., 1990).

Treatment with bST causes a dramatic increase in mammary uptake and utilization of nutrients for the synthesis of milk. It has been known that glucose is the major blood precursor of lactose. At least 85% of the carbon atom in milk lactose is derived from glucose. The linear relationship between glucose uptake by the mammary gland and milk volume reflects increased lactose synthesis along with the dilution to maintain osmolarity of milk (Chalupa and Sniffen, 2000). It has been reported that an increase milk yield in response to growth hormone treatment requires partitioning of nutrients to accommodate an increase in rates of milk synthesis. A decreases glucose uptake in skeletal muscle and adipose tissues, whereas its increases glucose uptake in the mammary gland (Davis et al., 1988; Fullerton, 1989 and Zhao et al., 1996). In the present study, the concentration of arterial plasma glucose slightly decreased during bST treatment which was different from the result of Peel et al. (1983), in which glucose concentration was unchanged during treatment at both early and late lactation (Miller et al., 1991). However, a significant rise in plasma glucose concentrations in goats treated with ovine growth hormone (Faulkner, 1999) and cows treated with pituitary-derived bovine growth

hormone (Fleet et al., 1988) have been reported. Mammary A-V difference and the extraction ratio of glucose in the present study showed a tendency to elevate during bST administration. However, an increased mammary uptake of glucose in the present study was mainly resulted from increases in both mammary plasma flow and mammary A-V difference. In the present study, the absence of hyperglycemia in response to bST treatment may reflect a rapid enhanced mammary uptake of glucose following its mobilization from glycogen stores and hepatic gluconeogenesis (Fullerton, 1989).

The daily output of the major milk constituents (lactose, fat, protein) was elevated by an amount comparable to milk volume in bST-treated cows (Bauman and Vernon, 1993, Burton et al., 1994 and Etherton et al., 1998). Milk triglycerides are synthesized in the mammary epithelial cells. The fatty acids used to synthesize the milk triglycerides arise from both blood lipids and from *de novo* synthesis within the mammary epithelial cells. An increased fat content in milk due to bST injection has been observed previously (Pocius and Herbein, 1986). Elvinger et al (1988) showed an increased yield of milk fat without change in percentage composition because of increased milk yield. However, an increase in milk fat after bST injection would relate to an increase in the mobilization of long-chain fatty acids from body reserves when cows are in negative energy balance (Eppard et al., 1985; Bitman et al., 1984 and McDoweel et al., 1987.).

In the present study, the concentration of milk fat showed tendency to increase after bST treatment, the concentration of arterial plasma triglyceride decreased throughout the experimental period. Likewise the results of Miller et al. (1991), which showed significant decrease in the plasma triglyceride level in mid-lactating cows treated with bST. These results indicate that bST has no effect or little changes on lipid mobilization for milk fat synthesis. In the present study, changes of milk fat may involve de novo synthesis in the mammary gland. De novo synthesis requires a source of two things: short chain carbon (acetyl-CoA) and reducing equivalents. In ruminant, the carbon sources used for fatty acid synthesis

are acetate and β-hydroxybutyrate (β-HBA). Acetate seem to be an important carbon source for medium chain length of fatty acid. In the present study, the arterial plasma acetate concentration slightly increased during bST treatment, which was similar to the results of Fullerton et al. (1989) who found a significant increase in the level of plasma acetate in bST-treated cows. However, it does differ from results of Miller et al. (1991) and Fleet et al. (1988) that showed a decrease in the level of plasma acetate. Different results reported by Miller et al. (1991) may be due to difference in the stages of lactation in animals used.

The mammary A-V difference and the extraction ratio of acetate in this study were tended to elevate in the treatment group. However, similar observation for acetate uptake by the mammary gland was resulted from increases in both mammary plasma flow and mammary A-V difference. Fullerton et al (1989) showed that the rate of acetate uptake was increased after 7 d of bST treatment and remained elevated for 10 d post-treatment. In the present study, animals received bST injection showed no effecte on the concentration of plasma β-hydroxybutyrate, mammary A-V difference and the extraction ratio. However mammary β–hydroxybutyrate uptake increased throughout the experimental period. The increased uptake of β–hydroxybutyrate in the present study was entirely due to an increase in mammary blood flow.

Peel and Bauman (1987) reported that administration of bST did not change milk protein percentage when cows were in positive nitrogen balance, but the milk protein percentage of cows in negative nitrogen balance tended to decline. In the present study, milk protein tended to elevate a few day after injection. It slightly declined throughout the experimental period. It is possible that animals used in the present study was late lactating cow, a low milk yield is not induced to be negative nitrogen balance.

In conclusion, bST exerts it effect on mammary function to stimulate milk secretion in 87.5% late lactating crossbred Holstein cattle by involving of changes both extra-mammary factors (mammary blood flow) and intra-mammary factors (mammary nutrients uptake). The present study confirm the mechanism by which growth hormone affect mammary gland function indirectly by the action of IGF-1. The action of IGF-1 may cause an increase in blood flow to mammary gland and presentation of milk precursors to the gland.