CHAPTER I
INTRODUCTION

1.1 Background and justifications

A large proportion of the nutrients used by the ruminant animals are the end products of rumen fermentation, primarily are the volatile fatty acids (VFAs), glucose, amino acids, and microbial proteins synthesized. Consequently, it is imperative to manage the rumen to optimize microbial growth and fermentation. The major nutrients needed by rumen microbes are proteins and carbohydrates sources, which are required to maximize microbial growth. Two general divisions of protein in feeds are ruminally degradable protein (RDP), which is available for degradation in the rumen by microbes, and ruminally undegradable protein (RUP), which escapes microbial degradation in the rumen, but it may have the potential to be digested in the small intestine (NRC, 2001). RDP is required for ruminal fermentation because it provides the mixture of peptides, free amino acids (AA), ammonia, for the synthesis of microbial protein. RDP is the sum of protein fraction A, B_1, B_2, and B_3 (Sniffen et al., 1992) of feedstuffs degradation. Soluble proteins (AB_1) are assumed to immediately available for utilization by rumen microbes and chemically defined as the protein fractions dissolved in a borate phosphate buffer. The rate of which RDP is degraded in the rumen can affect the amount of ammonia nitrogen (NH_3-N) production that escapes microbial capture, depending upon the availability of readily fermentable carbohydrate sources to provide ATP for microbial protein production (Hoover and Stokes, 1991). On the other hand, if there is insufficient rumen-available energy, or the degradation rates of RDP and carbohydrate are not synchronized; then, the excess NH_3-N will be absorbed into portal blood vessel and transported to the liver, where it is converted into urea. Depending on prevailing dietary conditions, 40 to 60 % of liver urea output is excreted in urine form (Huntington, 1989). Which represents an irretrievable loss of nitrogen (N) to the animal and it is also a source of pollutant to the environment that has created lots of environmental concerns.

Carbohydrates are the major source of energy in diets fed to dairy cattle and it usually comprises 60 to 70 % of the total diet. The main function of carbohydrate is to provide energy for rumen microbes and the host animal. A secondary function of certain types of carbohydrates is to maintain the health of gastrointestinal tract. The two major classifications of carbohydrates in ruminant diets are neutral detergent fiber (NDF) and non-fiber carbohydrates (NFC). The most predominant carbohydrates are cellulose and hemicelluloses which are constituents of NDF, and starch, sugars contained in NFC (Allen, 1991). Therefore, the major nutritional differences between NDF and NFC are their site of digestion, the rate and extent of digestion. Starch and sugars are considered to be highly digestible and rapidly fermentable as compared to the carbohydrates in NDF (NRC, 2001). Increased rate and extent of carbohydrate availability to rumen microorganisms can positively impact to microbial protein synthesis. Moreover, the different types of NFC have shown difference in quantity of microbial crude protein yields (Hall and Herejk, 2001).

The sugar content of the most common feeds fed to lactating cows can range from less than 1 to 20 % of diet dry matter (DM), total sugar content often be only 1.5 to 3.0 % of diet DM. Sugars are rapidly fermented in the rumen than starch (Chamberlain et al., 1993). Sugar and starch can be fermented into lactic acid in the rumen (Hungate, 1966). Moreover, the Cornell Net Carbohydrate and Protein System (NRC, 1996) indicated that the organisms that ferment soluble sugars could contribute approximately 18 % of microbial protein more than that ferment starches in high moisture corn. Providing rapidly fermentable carbohydrate sources may promote ruminal papillae development and increase VFA absorption; therefore, enhancing the transition of non-lactating to lactating cow diets (Ordway et al., 2002). Sucrose stimulated DMI (Broderick et al., 2008) and enhanced rumen microbial protein synthesis (Khalili and Huhtanen, 1991; Lean et al., 2005; Hall and Weimer, 2007). A reduction in ruminal ammonia concentration has been noted nearly in all studies in which sugar is added to the diet (Broderick and Radloff, 2004; Penner and Oba, 2009). The reductions in ruminal ammonia suggested that the more efficient utilization of the soluble nitrogen components of the diet. Improved microbial growth can result from an increase in microbial efficiency, or by simply provides a greater amount of fermentable carbohydrate. If sugars can improve microbial growth by

causing a better synchronization between rapidly available nitrogen and carbohydrate, alterations in fermentable carbohydrate may alter ruminal response to protein solubility, or degradability, and show the positive effects on low quality roughage utilization (Heldt et al. 1999; Zanton et al., 2007). The amount of microbial protein arriving at the small intestine may be influenced by RDP, and potentially, by NFC type. Therefore, it may need to be complemented with different amounts of soluble protein to optimize nutrient supply to the cow. Our hypothesis is that optimizing ratios of soluble protein to soluble carbohydrate diets would improve nutrients digestion by promoting microbial growth and utilization of cows fed on low-quality roughage. To prove this hypothesis there are series of experiments to be conducted.

1.2 The objectives of the thesis

1.2.1 To evaluate the effects of soluble protein and soluble carbohydrate on *in vitro* fermentation and nutrient digestion

1.2.2 To evaluate the effects of soluble protein and soluble carbohydrate in TMR diets on ruminal fermentation and digestion response of cannulated cows

1.2.3 To investigate the optimal ratio of soluble protein to soluble carbohydrate on total tract nutrient digestibility, ruminal microbial protein synthesis, and lactation performance of lactating dairy cows

1.3 Expected outcomes

The results obtained from the series of experiment may contribute there following outcomes

1.3.1 To obtain the information on the effects of soluble protein and soluble carbohydrate on *in vitro* fermentation and nutrient digestion

1.3.2 To obtain the information on the effects of soluble protein and soluble carbohydrate in TMR diets on ruminal fermentation and digestion response of cannulated steers

1.3.3 To obtain the information on the effects soluble protein and soluble carbohydrate on total tract nutrient digestibility, ruminal microbial protein synthesis, and lactation performance of lactating dairy cows

1.3.4 To generate information to make decision on use the optimum ratios of soluble protein and sugar in lactating dairy cow's diet for smallholder farmers