

CHAPTER I

INTRODUCTION

1. Background and Justifications

Feeds and foods are not equal in their capacity to support the animal functions of maintenance, growth, reproduction and lactation (Van Soest, 1994). They supply energy and essential nutrients in the form of protein, vitamins and minerals. Energy and protein are often the most limiting factors for ruminants and have received the most attention in evaluation systems (Mapato et al., 2010). In the formulation of diets for ruminants, it is important to optimize the balance between the energy and protein contents of the feed, so that balanced rumen fermentation occurs and maximum voluntary intake and feed utilization can achieve (Preston and Leng, 1987).

Dietary protein plays an important role in the nutrition of ruminants, since besides providing amino acids; it is also a source of nitrogen for the synthesis of microbial protein (Nocek and Tamminga, 1991). Therefore, it is considered the most important nutrient and also the most expensive, which must be efficiently used. Strategies to reduce the feed cost without interfering negatively in production have been constantly researched. The substitution of traditional feeds in the diets of ruminants is common as economic condition changes (Ørskov, 1999). Soybean meal (SBM) has long been used as a prominent source of crude protein for ruminants, however, with its increasing price, the use results in higher cost of production. Thus, use of urea as a protein replacement is attractive in ruminant diets because of its low cost compared with true protein feeds such as SBM (Wanapat, 2009; Xin et al., 2010).

Since the early demonstration by Krebs (1937), Hart et al. (1939), Reid (1953), Virtanen (1966) of its potential value when fed to ruminants, urea has become widely used as a substitute for preformed protein in ruminant diets. The presently accepted mechanism of urea action in ruminant nutrition is the hydrolysis of urea by rumen urease to ammonia plus carbon dioxide, carbohydrate fermentation to volatile fatty acids, amination of keto acids to give amino acids, incorporation of the amino

acids into microbial protein, and digestion of the microbial cells in the small intestine with subsequent absorption of the resulting amino acids (Nocek and Russell, 1988; Nocek and Tamminga, 1991; Calsamiglia et al., 2008). However, amount of urea can be used in diets is limited due to their rapid hydrolysis to NH_3 in the rumen by microbial enzymes (Golombeski et al., 2006; Highstreet et al., 2010). This rapid breakdown to NH_3 can occur at a much faster rate than NH_3 utilization by the rumen bacteria, resulting in accumulation and escape of NH_3 from the rumen. The net result is that a potentially large part of the nitrogen from NPN sources is excreted in the urine and can contribute to environmental pollution (Broderick et al., 2009; Huntington et al., 2009; Inostroza et al., 2010).

The topic of efficiency of protein use by ruminants has gained attention by environmentalists and government regulators in many parts of the world (Robinson, 2010). Increasing public concern has been focused on ruminant production systems as a major nonpoint source of pollution, which has spurred research aimed to reduce N excretion (Van Amburgh et al., 2007; Wanapat et al., 2009). Nutrient losses may affect ground and surface water quality; in addition, NH_3 and nitrous oxide emissions can affect air quality, and the latter has been implicated as a significant contributor to global warming, having a 310× more harmful mass-specific effect than CO_2 as a global warming agent (Marini and Van Amburgh, 2005). Therefore, ruminant production systems should support nature conservation, and the environmental load should be low.

An alternate solution could be to modify urea to control its rate of release so that NH_3 release more closely parallels carbohydrate digestion (Pinos-Rodríguez et al., 2010). Slow-release urea compounds, which have been fed to ruminants, include biuret, starea, urea phosphate, coatings based on oil, formaldehyde treated urea and polymer-coated urea (Taylor-Edwards et al., 2009). These compounds have not been as advantageous as urea because a substantial part of the NPN in them may leave the rumen without being converted to NH_3 , reducing its incorporation into microbial protein (Tedeschi et al., 2000; Galo et al., 2003; Firkins et al., 2007). More recently, slow-release properties have been achieved by using urea bounding to substrates like calcium chloride to control the release rate of NH_3 from urea (Huntington et al., 2006; Golombeski et al., 2006). In an earlier *in vitro* experiment, urea-calcium sulphate

mixture products have been also demonstrated to reduce ruminal NH_3 concentrations as well as improve microbial population as compared with feed grade urea (Cherdthong et al., 2010).

Since urea is cheap it could be used for tropical ruminant production, providing it is controlled to enable slow-release and/or synchronized with highly soluble carbohydrate in the rumen such as cassava chip, and should be of great value in improving N utilization (Nocek and Tamminga, 1991; Chanjula et al., 2007; Broderick et al., 2008; Russell et al., 2009). Cassava (*Manihot esculenta*, Crantz) is grown widely in Thailand and the price is relatively low (Khampa et al., 2006; Wanapat, 2009). It can be grow to produce cassava foliage as a protein feed sources (Promkot and Wanapat, 2009) and tuber is a energy source for animal feeds. Cassava chip contained high level of nonstructural carbohydrate and were highly degradable in the rumen as compared with other energy sources including corn meal (Sommart et al., 2000; Chanjula et al., 2003). Recently a study by Wanapat and Khampa (2007) reported that a concentrate based on a high proportion of cassava chips and a high urea level could improve rumen fermentation efficiency and rumen microbial protein synthesis in dairy steers. However, data on supplementation of slow-release NH_3 products in concentrate cassava chip-based diets is rather limited. Therefore, the objectives of this study were to; (1) develop urea-calcium mixture products as a rumen slow- release ammonia and (2) investigate the supplementation of urea-calcium mixtures in concentrates containing high level of cassava chip with rice straw as a basal roughage on rumen dynamics and dairy milk production.

2. Scientific Hypothesis

2.1 Urea-calcium mixture product can be use as a rumen slow- release ammonia which would be enhanced ammonia utilization by rumen microorganism.

2.2 Using a urea-calcium mixture product in concentrates containing high level of cassava chip would improve performance efficiency of ruminants.

3. Objectives

3.1 To develop urea-calcium mixture products as slow-release rumen ammonia and fermentation characteristics of products with energy sources using the *in vitro* gas techniques.

3.2 To evaluate the effects of different nitrogen sources in concentrates containing high level of cassava chip with rice straw as a basal roughage on rumen ecology, rumen microorganisms, microbial protein synthesis, and digestibility of nutrients of beef cattle.

3.3 To investigate the supplementation of various urea-calcium mixtures in concentrates containing high level of cassava chip with rice straw as a basal roughage on feed intake, ruminal fermentation, microbial protein synthesis, and performance of lactating dairy cows.

4. Expected Outcomes

4.1 To obtain the information of urea-calcium mixture products as a new slow-release rumen ammonia with energy sources, in terms of ruminal ammonia concentration, nutrients digestibility, microbial population using the *in vitro* gas techniques.

4.2 To obtain the information of supplement of urea- calcium mixture in concentrate containing high level of cassava chip on feed intake, nutrients digestibility, rumen fermentation, microbial protein synthesis and microbial diversity in beef cattle.

4.3 To obtain the information of using urea- calcium mixture supplementation in concentrates containing high level of cassava chip with rice straw as a basal roughage on ruminal fermentation, microbial protein synthesis efficiency and milk production in lactating dairy cows.

4.4 To obtain the possibility to use urea-calcium mixture products as a potentially non protein nitrogen source in ruminant without any effect.

4.5 As information to make decision to use urea-calcium mixture products in ruminant feeding especially for smallholder farmers as well as commercial sector.