Slow-Release Urea

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Slow-release urea (SRU) is a coated non-protein nitrogen (NPN) source for ruminant nutrition. This study applied a meta-analytic technique to quantify the effect of a commercial SRU (Optigen®, Alltech Inc., Nicholasville, KY, USA) on the performance of beef cattle. Data were extracted from 17 experiments and analysed using the random-effects model to estimate the effect size of SRU on dry matter intake (DMI), crude protein intake (CPI), live weight gain (LWG) and feed efficiency (FE) of growing and finishing beef cattle. There was no effect of feeding SRU on the overall DMI and CPI of beef cattle. Dietary inclusion of SRU improved the overall LWG (+92 g/d/head) and FE (+12 g LWG/kg DMI/head) of beef cattle. Notably, SRU supplementation in growing cattle exhibited a better improvement on LWG (130 vs. 60 g/d/head) and FE (18 vs. 8 g LWG/kg DMI/head) compared with finishing cattle. Moreover, SRU showed consistent improvements on the LWG and FE of beef cattle under several study factors. Simulation analysis indicated that positive effects of SRU on LWG and FE improved profitability through reduction in feed cost and reduced the emission intensity of beef production. These results indicate that SRU is a sustainable NPN solution in beef cattle production.

Keywords: beef cattle ; rumen degradable protein ; urea ; growth performance ; feed efficiency

1. Introduction

The livestock industry is confronted with the challenges of using limited land and water resources to meet the growing demand for animal protein in an environmentally sustainable way. Ruminants are important components of a sustainable livestock sector because of their ability to digest and convert human inedible biomass to high-quality edible protein (meat and milk), primarily due to the intricate consortium of microbes residing in their rumen [1]. Crude protein (CP) in ruminant nutrition comprises of the rumen degradable protein (RDP) and rumen undegradable protein (RUP) fractions. Dietary RDP is degraded in the rumen to produce ammonia, which is synchronised with fermentable energy for rumen microbial growth and protein synthesis [2]. Microbial crude protein (MCP) and RUP reaching the small intestine constitute the metabolizable protein absorbed to meet the protein requirement of ruminants [3]. Microbial protein accounts for 50% to 80% of the total absorbable protein, highlighting its significance as a crucial component of metabolizable protein [2][4].

2. Specifics

Dietary RDP is derived from nitrogenous compounds, which comprise of both non-protein nitrogen (NPN) sources and soluble true protein from plant and animal protein sources. The NPN sources are typically less expensive than true protein sources and feed-grade urea is often the most available NPN source used in ruminant diets. However, dietary utilisation of urea is limited due to its rapid hydrolysis to ammonia, exceeding the rate of carbohydrate fermentation in the rumen [2]. The lack of synchronisation between rumen ammonia production and fermentable energy availability negatively affect the efficiency of MCP yield. Consequently, this condition reduces the amount of MCP outflow, which may decrease the availability of metabolizable protein for production purposes in ruminants [5]. The rapid ruminal hydrolysis of urea may elevate blood ammonia concentration and increase the risk of ammonia toxicity and related negative health impacts in ruminants [6]. Furthermore, rapid ruminal hydrolysis of NPN sources, including urea, could reduce nitrogen (N) utilisation efficiency and thus increase N excretion and ammonia volatilisation from manure resulting in negative environmental impacts [5].

Over the last three decades, coating technology has been utilised to produce slow-release urea (SRU) products that degrade less rapidly in the rumen with potential claims of improved synchronisation of ruminal ammonia with energy digestion for microbial protein synthesis. These products are usually available for feeding to all ruminant species (cattle, buffalo, sheep and goat). Cherdthong and Wanapat [2] provided a narrative review of scientific literature that highlighted the potential efficacy of SRU in enhancing the efficiency of rumen N capture, microbial protein synthesis, fibre digestion and improved ruminant production. Moreover, SRU could be an eco-friendly alternative for replacing a portion of vegetable protein sources and the slow formation of ammonia in the rumen could ensure no negative impacts on N excretion [7][8]. However, narrative reviews lack methodological approach and they are subjective to the author's interpretation of previous research, which may lead to biased conclusions [9].

It is often difficult to draw quantitative conclusions from the comparison of different research outcomes due to the diversity in study designs, experimental bias, poor statistical analysis and lack of application to a specific livestock production system [9]. These challenges can be overcome by the use of a meta-analysis, which is a rigorous statistical procedure for analysing a combined dataset obtained from multiple research studies [9][10]. A multitude of studies has utilised meta-analysis to provide quantitative and research-based evidence on the efficacy of nutritional products or interventions in beef cattle production [10][11][12]. To our knowledge, there is no published meta-analysis on the effect of SRU supplementation in beef cattle production. Thus, the objective of this study was to apply a meta-analytic technique to quantify the effects of SRU on the performance of growing and finishing beef cattle. In addition, the meta-analysis results were used to conduct a simulation analysis to evaluate the potential effect of SRU on the economic and environmental impacts of beef production.

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