Animal Feed Science and Technology 232 (2017) 40–48

Contents lists available at ScienceDirect

Animal Feed Science and Technology

journal homepage: www.elsevier.com/locate/anifeedsci

Effect of *Delonix regia* seed meal supplementation in Thai native beef cattle on feed intake, rumen fermentation characteristics and methane production

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ARTICLE INFO

Keywords:
Rumen fermentation
Beef cattle
Delonix regia seed meal
Methane emission

ABSTRACT

The aim of this research was to investigate the effect of supplementing *Delonix regia* (DR) seed meal on feed intake, digestibility, rumen fermentation, nitrogen balance and CH_4 production in Thai native beef cattle fed on rice straw. Four Thai native beef cattle with the initial body weight (BW) of 100 ± 5.0 kg were randomly assigned according to a 4 × 4 Latin square design to receive DR seed meal supplementation at 0, 90, 180 and 270 g/d. The present results revealed that the total intake (g/kg $BW^{0.75}$) was significantly increased with the inclusion of dry matter (DM) seed meal at 270 g ($P < 0.05$). DM and OM digestibility were decreased when increasing DR seed meal levels ($P < 0.05$). Ruminal NH_3-N concentration increased in beef cattle receiving DR seed meal. Supplementation of DR seed meal did not alter fungal zoospores' concentration ($P > 0.05$), whereas the protozoal population was at 0, 4 h post feeding, and the mean values reduced when increasing the levels of DR seed meal supplemented ($P < 0.05$). The concentration of propionic acid at 4 h post feeding and its average concentration were significantly highest when 270 g DR seed meal was supplemented ($P < 0.05$). Estimation of CH_4 concentrations and CH_4 per dry matter intake were found reduced when increasing its DR seed meal concentration. In addition, N absorption, N retention and proportion of N retention to N intake were enhanced when 270 g DR seed meal was supplemented ($P < 0.05$). Thus, the inclusion of DR seed meal at 270 g/d resulted in improving total feed intake, rumen fermentation and N balance whereas there was reduced DM digestibility, protozoal population and CH_4 production in beef cattle fed rice straw base.

1. Introduction

Beef cattle are economically important domestic animals and have a long tradition in Thai agriculture. However, beef production

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http://dx.doi.org/10.1016/j.anifeedsci.2017.08.004
Received 30 March 2017; Received in revised form 16 July 2017; Accepted 2 August 2017

in Thailand is often suboptimum, characterized by slow growth performance and low reproductive efficiency (Cherdthong et al., 2014). This could be due to insufficient quantities of energy and protein during the dry season, especially when the cattle feed on rice straw. Thus, the new feed resources that are rich in nutrients and available in each area may benefit from further research.

Livestock contributes to about 18% to the global anthropogenic greenhouse gas (GHG) emissions, accounting for about 37% of the total anthropogenic methane (CH_4) and 65% of global anthropogenic nitrous oxide. CH_4 is produced normally during the fermentation of feed by methanogenic bacteria (Hristov et al., 2013). The removal of ruminal protozoa can also reduce CH_4 production as some population of methanogens remains attached to protozoa (Cieślak et al., 2016). Tannin and saponin-containing tropical plants have been demonstrated to decrease CH_4 production both *in vitro* and *in vivo* experiments. The inhibitory effect of these compounds on rumen methanogenesis have been ascribed due to their direct effect on methanogenesis archaea, protozoal associated CH_4 production and indirectly through a depression of fiber digestion in the rumen. Anantasook et al. (2016) demonstrated that supplementing *Terminalia chebula* Retz. containing tannins and saponins could improve rumen fermentation by reducing CH_4 production and protozoa populations' *in vitro* gas technique. They also investigated the inhibitory effects of tannins and saponins from *Samanea saman* could depress CH_4 production, methanogens and protozoal populations in rice straw-fed dairy cows (Anantasook et al., 2015). Similarly, Gunun et al. (2016) showed that the concentration of CH_4 was reduced at 8% when goats supplemented with condensed tannins in Mao (*Antidesma thwaitesianum* Muell. Arg.) seed meal. Thus, directly inhibitory to methanogens, tannins and saponins have been shown to lower protozoal numbers, which may also decrease protozoal-associated methanogenesis.

Delonix regia (DR) is one kind of the plants containing secondary compound. It is abundant during the dry season and contains a large amount of underutilized condensed tannins and saponins. DR seeds contains 20.50% and secondary compounds of condensed tannins and saponins at 90–95 mg/100 g and 10–15%, respectively (Alemede et al., 2010; Kaga, 2013). The incorporation of DR seed into animal diets potentially may enable manipulation of rumen ecosystems. DR seed meal has been used as a protein source in animal diets and could be enhancing carcass weight in tilapia (Bake et al., 2014), rabbits (Kaga, 2013), broilers (Egena et al., 2008) and Savanna Brown does (Alemede et al., 2010). Recently, Supapong et al. (2017) demonstrated that supplementation of DR seed meal at 11.7 mg resulted in improved *in vitro* kinetics gas and DM digestibility while reducing CH_4. However, utilization of condensed tannins and saponins in DR seed meal for beef cattle has not been studied. The aim of this research was to investigate the effect of supplementation of DR seed meal on feed intake, digestibility, rumen fermentation, nitrogen balance and CH_4 production in Thai native beef cattle fed on rice straw.

2. Materials and methods

Animals involved in this study were approved by the Animal Ethics Committee of Khon Kaen University (record no. ACUC-KKU 34/2559), based on the Ethic of Animal Experimentation of National Research Council of Thailand.

2.1. Dietary preparation

Rice straw and concentrate diet were obtained from the Ruminant Metabolism Center, Tropical Feed Resources Research and Development Center (TROFREC). DR seed pods were collected from the Khon Kaen province in Thailand from August to October 2015. The pods were sun-dried for 2–3 weeks, and then the pods were easily opened for seed collection. DR seed pods were dried at 60 °C for 48 h, ground to pass through a 1-mm sieve (Cyclotech Mill, Tecator, Hoganas, Sweden) and used for experimental test.

2.2. Animals, experimental design and feeding

Four, Thai native beef cattle with initial body weight (BW) of 100 ± 5.0 kg were randomly assigned according to a 4 × 4 Latin square design to receive DR seed meal supplementation at 0, 90, 180 and 270 g/d. A concentrate mixture (Table 1) was fed to animals at 0.5% BW daily. DR seed meal and concentrate were offered in two equal meals per day at 0700 and 1600. Cattle were fed rice straw ad libitum basis and clean fresh water all times. All animals were kept in individual pens. The experiment was conducted for 4 periods with 21 days per each. The first 14 days were for adaptation period and last 7 days were for samples collection as animals were moved to metabolism crates and fed the rice straw at 90% of the previous voluntary feed intake of straw. Concentrate was still offered at 0.5% BW daily.

2.3. Sample collection and sampling procedures

The samples of DR seed meal, concentrate, and rice straw offered and refusals samples were collected during the last 7 days of each period. Fecal and urine samples were collected during the last 7 days of each period by using total collection method as animal were on the metabolism crates to study on the nutrient digestibility and nitrogen balance. The fecal samples were collected about 5% of total fresh weight and divided into two parts; first part for DM analysis every day and second part was kept in refrigerator and pooled by cattle at the end of each period for chemical analysis. Feeds, refusals and fecal samples were chemically analyzed DM (ID 967.03), N (ID 984.13), EE (ID 954.02), ash (ID 942.05), and ADF (ID 973.18) according to the AOAC (1998) method. The neutral detergent fiber (NDF) in samples was estimated according to Van Soest et al. (1991). Content of condensed tannins in DR was analyzed by using the modified vanillin-HCl method based on Burns (1971). Saponins were analyzed by using the modified vanillin-sulfuric acid method based on Wang and Fang (2004). Table 1 present the ingredient and chemical composition of concentrates, DR and rice straw used in the experiment. Metabolizable energy (ME) was calculated according to the equation described by Robinson