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ScienceDirect
Animal Feed Science and Technology
146 (2008) 242–258
ANIMAL FEED SCIENCE AND TECHNOLOGY
www.elsevier.com/locate/anifeedsci

Impacts of rumen fluid modified by feeding *Yucca schidigera* to lactating dairy cows on *in vitro* gas production of 11 common dairy feedstuffs, as well as animal performance

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Received 22 August 2007; received in revised form 10 December 2007; accepted 21 December 2007

Abstract

The objective was to determine effects of feeding increasing levels of a *Yucca schidigera* extract (YSE) to dairy cows on 24 h *in vitro* gas production and 27 h *in vitro* neutral detergent fibre (aNDFom) digestion of 11 common dairy feedstuffs, as well as *in vivo* rumen fermentation and performance of the cows to which the YSE was fed. The principle was to use YSE to potentially modify the rumen microbial population *in vivo* and measure subsequent impacts of the adapted rumen fluid on feedstuff fermentation *in vitro*. Four rumen cannulated late lactation Holstein cows (810 ± 54.7 kg body weight) were used in a 4×4 Latin Square design experiment with 14 d periods. Cows were housed in pens with individual feeding gates and had *ad libitum* access to water while fed a total mixed ration (TMR) of alfalfa hay, corn grain, barley grain, dried distillers grains, whole cottonseed, beet pulp, soybean meal, almond hulls, rumen inert fat and a mineral/salt mixture. Based upon sarsaponin assay of four commercial YSE products, Monterey Sarsaponin 15® was selected and added to the TMR to provide 0, 5, 10 or 15 g of sarsaponin/cow/d. Rumen fluid from each cow in each period was utilized for *in vitro* gas determinations to measure gas production and aNDFom digestion from the

Abbreviations: ADFom, acid detergent fibre; BW, body weight; aNDFom, neutral detergent fibre; dNDF30, NDFom digestible at 30 h of *in vitro* fermentation; CP, crude protein; NE, net energy; TMR, total mixed ration; VFA, volatile fatty acid; YSE, *Yucca schidigera* extract.

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0377-8401/$ – see front matter
doi:10.1016/j.anifeedsci.2007.12.010

test feeds. There was a strong linear effect (P=0.002), at an increasing rate (quadratic P=0.08), to increased extent of gas production with increased feeding of YSE. There was a quadratic effect to maximum rate of gas production (P=0.01) at the 5 g sarsaponin level. At 4 h of fermentation, gas production increased linearly (P<0.05), at an increasing rate (P<0.002), for almond hulls, barley grain and soybean meal with increasing levels of YSE. Gas production from barley grain had a quadratic effect (P<0.01), suggesting a maximum at about the 5 g sarsaponin feeding level. Gas production at 24 h of fermentation increased linearly (P=0.03), at a decreasing rate (P<0.03), but only soybean meal had a quadratic tendency (P=0.08) to minimum gas production at about the 5 g level of sarsaponin. *In vitro* fermentation of aNDFom at 27 h was not impacted by treatment. *In vivo* rumen pH, concentrations of total volatile fatty acids and rumen protozoal counts were not impacted by YSE feeding level, as were milk production, milk components and net energy (NE) balance. However, correlations between NE output and the proportional increases in 4 h gas production with increasing levels of YSE in the diet suggest that this measure may be predictive of animal responses to this YSE. Finally, multivariate analysis, used to create equations to predict impacts of the nutrients in the 11 feedstuffs on their proportional increase in 4 h gas production, suggests that the increase in 4 h gas production of any feed may be predicted from its organic nutrient profile, offering the potential to determine the optimal feeding level of sarsaponin in any TMR based on its nutrient profile.

Keywords: Fermentation; Sarsaponin; Volatile fatty acids; Ammonia

1. Introduction

Yucca schidigera is a desert plant native to the arid deserts of the Mexican states of Baja California, Guerrero and Huajaca. It averages 4.5 m in height with 1 m leaves and is also known as "Spanish Dagger" or "Mohave Yucca" (Cheeke, 2000). Most commercial production of *Y. schidigera* is in the arid Mojave and Sonoran deserts of the southwestern United States and northwestern Mexico. In most processes, the trunk and root of the plant are harvested, mechanically macerated, ground and dried to produce a yucca powder, or squeezed in a press to produce a yucca juice, which is then concentrated by evaporation to create a yucca extract (Cheeke, 2000; Øleszek et al., 2001). The major active components of the *Y. schidigera* plant used as animal feed additives are the steroidal saponins (Cheeke, 1998). According to Wang et al. (2000b), steroidal saponins form complexes with cell walls of cellulolytic and amylolytic bacteria, which disrupt membrane function and cell growth of some bacterial genera, thereby reducing their numbers in the rumen. According to Wina et al. (2005), raw yucca extract contained 44 g/kg of DM of steroidal saponins, which are the secondary plant glycosides with attached sugars (Wang et al., 2000a). However, since yucca extracts are produced to company specification, individual products contain different concentrations of sarsaponin and, therefore, may have varying anti-microbial impacts in the rumen.

Increasing rumen digestibility of carbohydrates is important to the dairy industry because it affects the amount of feed energy that is released to meet animal metabolic needs. Supplementation of anti-microbial ionophores was effective in increasing efficiency of utilization of structural carbohydrates. However the dairy industry is increasingly looking for 'natural' products that mimic the beneficial actions of ionophores, particularly in the European Union due to the recent ban of feeding ionophores to ruminants.