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Effects of extruding wheat dried distillers grains with solubles with peas or canola meal on ruminal fermentation, microbial protein synthesis, nutrient digestion, and milk production in dairy cows

R. M. Claassen, D. A. Christensen, and T. Mutsvangwa[1]
Department of Animal and Poultry Science, University of Saskatchewan, Saskatoon, SK, Canada, S7N 5A8

ABSTRACT

Our objective was to examine the effects of feeding coextruded and nonextruded supplements consisting of wheat dried distillers grains with solubles with peas (WDDGS-Peas) or canola meal (WDDGS-CM) on ruminal fermentation, omasal flow, and production performance in Holstein cows. Eight cows (4 ruminally cannulated) were used in a replicated 4 × 4 Latin square with 28-d periods and a 2 × 2 factorial arrangement of dietary treatments. Dietary treatments were coextruded or nonextruded mixtures of WDDGS-peas and WDDGS-CM that were included in total mixed rations at 15.1% [dry matter (DM) basis]. Diet had no effect on DM intake. Milk yield was greater in cows fed coextruded diets compared with those fed nonextruded diets. Milk fat content was greater in cows fed nonextruded diets compared with those fed coextruded diets, but milk fat yield was greater in cows fed coextruded diets compared with those fed nonextruded diets. Milk yield tended to be greater and milk protein yield was greater in cows fed WDDGS-peas compared with those fed WDDGS-CM. Cows fed nonextruded diets had a greater milk urea-N concentration compared with those fed coextruded diets. Cows fed coextruded diets had greater ruminal digestion of DM and tended to have greater ruminal digestion of organic matter compared with those fed nonextruded diets. Total-tract digestibilities of organic matter, crude protein, ether extract, and starch were greater, whereas that of acid detergent fiber and neutral detergent fiber tended to be greater in cows fed coextruded compared with those fed nonextruded diets. Total-tract digestibility of ether extract was lower whereas that of starch was greater and that of crude protein tended to be greater in cows fed WDDGS-peas compared with those fed WDDGS-CM. Total N excretion and milk N efficiency were unaffected by diet. Ruminal NH_3-N concentration tended to be greater in cows fed WDDGS-CM compared with those fed WDDGS-peas. Ruminal propionate concentration was greater whereas plasma urea-N concentration tended to be lower in cows fed coextruded compared with those fed nonextruded diets. Plasma glucose concentration was greater in cows fed diets containing WDDGS-CM compared with those fed diets containing WDDGS-peas, but the difference in plasma glucose concentration between WDDGS-CM and WDDGS-peas was greater in cows fed coextruded diets compared with those fed nonextruded diets. In summary, feeding coextruded compared with nonextruded supplements or WDDGS-peas compared WDDGS-CM increased yields of milk, fat, and protein.

Key words: dairy cow, dried distillers grains with solubles, peas, canola meal

INTRODUCTION

Traditionally, ethanol production in western Canada has used wheat as the major feedstock. Recently, the rapid expansion of ethanol production has resulted in an abundant supply of wheat dried distillers grains with solubles (**WDDGS**) that can be used as a protein source for dairy cows. Perusal of the literature indicates that several recent studies (Abdelqader and Oba, 2012; Chibisa et al., 2012; Chibisa and Mutsvangwa, 2013; Maxin et al., 2013a) have demonstrated that WDDGS can be used as a replacement for traditional protein supplements such as canola meal (**CM**) without compromising milk production. In western Canada and parts of the United States, dairy cow diets are typically formulated to contain CM as the major source of protein because it is readily available and is a high-quality protein supplement (Hickling, 2008; Mulrooney et al., 2009). It is well established that major differences exist in the chemical compositions and ruminal degradabilities of CM and WDDGS (Boila and Ingalls, 1994). When compared with CM, the available data indicates that WDDGS is greater in CP content (43.6 vs. 39.5%; Boila and Ingalls, 1994), but is lower in Met

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[1]Corresponding author: tim.mutsvan@usask.ca

(1.75 vs. 2.68 g/16 g of N) and, particularly, Lys (2.04 vs. 5.30 g/16 g of N) contents (Boila and Ingalls, 1994). Also, ruminal N degradability (as assessed using the in situ technique) of WDDGS was much lower (36.5 vs. 63.4%) when compared with CM (Boila and Ingalls, 1994). In vivo measurements using the omasal sampling technique also indicated that RDP supply decreased whereas RUP supply increased when WDDGS replaced CM in lactating cow diets (Chibisa et al., 2012). Peas (*Pisum sativum*) contain relatively high levels of CP (24 to 28%) and starch (48%; Petit et al., 1997; NRC, 2001), so they have been used as a cheaper replacement for more expensive protein and energy sources in diets for lactating dairy cows without negatively affecting milk yield and composition (Petit et al., 1997; Khorasani et al., 2001; Masoero et al., 2006). When compared with WDDGS, peas contain less CP, which is more ruminally degradable (78% RDP as a percent of CP); however, peas contain greater levels of Lys compared with WDDGS (NRC, 2001). These differences in chemical composition and ruminal degradability among WDDGS, CM, and peas causes one to consider that judicious combinations of WDDGS with CM and WDDGS with peas would supply sufficient amounts of RDP to meet microbial N requirements, and also providing adequate amounts of RUP with a good AA (Lys and Met) balance to optimize milk production in high-producing dairy cows.

Altering the physical structure of proteinaceous feedstuffs through heat processing methods such as extrusion may help to protect dietary protein from ruminal degradation, thus increasing the postruminal supply of digestible RUP that might benefit high-producing dairy cows (NRC, 2001). The exposure of proteinaceous feedstuffs to heat processing reduces ruminal protein degradation through protein denaturation and the formation of complexes (e.g., protein-protein linkages) that are resistant to ruminal degradation (NRC, 2001). Numerous studies (Focant et al., 1990; Walhain et al., 1992; Gonthier et al., 2004) have reported decreased ruminal protein degradation when proteinaceous feedstuffs such as flaxseed and peas have been subjected to extrusion processing. Because of the differences in chemical composition and ruminal degradability among WDDGS, CM, and peas indicated previously, the coextrusion of judicious combinations of WDDGS with CM and WDDGS with peas might be of benefit in terms of improving ruminal N utilization and postruminal RUP supply. To our knowledge, comparative studies do not exist that have investigated the effects of feeding nonextruded or coextruded combinations of WDDGS-CM and WDDGS-peas on ruminal digestion, N utilization, and production performance in dairy cows. Therefore, our specific objective was to determine the interactive effects of feeding nonextruded or coextruded mixtures of WDDGS-CM and WDDGS-peas on ruminal fermentation characteristics, microbial protein production, omasal nutrient flow, and production performance of high-producing dairy cows.

MATERIALS AND METHODS

Animals and Experimental

Eight multiparous lactating Holstein cows (712 ± 54 kg of BW; 90 ± 31 DIM at the beginning of the experiment) housed in individual tiestalls at the University of Saskatchewan Greenbrae Dairy Research Facility were used in this study. The experimental design was a replicated 4 × 4 Latin square design with a 2 × 2 factorial arrangement of dietary treatments. Each experimental period was 28 d in length, consisting of 20 d of diet adaptation and 8 d of sample and data collection. Four cows in 1 Latin square were ruminally cannulated to facilitate ruminal and omasal sampling. The University of Saskatchewan Animal Care Committee approved the use of cows for this experiment (UCACS Protocol No. 20040048), and they were cared for in accordance with the Canadian Council on Animal Care (1993) regulations.

Dietary Treatments and Feeding Management

Experimental treatments were combinations of 2 protein supplements fed in nonextruded and coextruded forms as follows: (1) nonextruded WDDGS-peas; (2) coextruded WDDGS-peas; (3) nonextruded WDDGS-CM; and (4) coextruded WDDGS-CM. Extruded diets were processed at O and T Farms (Regina, SK, Canada) using a Insta-Pro International 2500 series extruder (Des Moines, IA) with a custom 5-hole (5/16-inch hole) nose cone. Extruding temperatures for coextruded WDDGS-peas and WDDGS-CM supplements were 161°C (range = 131–184°C) and 160°C (range = 142–179°C), respectively. Single batches of WDDGS, CM, and peas were used for nonextruded and coextruded supplements for the entire study. The chemical compositions of the nonextruded and coextruded WDDGS-peas and WDDGS-CM supplements are presented in Table 1. The experimental diets were fed as TMR and contained 7.9% WDDGS and 7.2% CM or peas (Table 2). The forage-to-concentrate ratio of the TMR was 47:53, with the forage component of the TMR being a mixture of barley silage (approximately 68% on a DM basis) and chopped alfalfa hay (32%; Table 2). By design, the inclusion levels of various protein supple-