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# Effects of feeding canola meal or wheat dried distillers grains with solubles as a major protein source in low- or high-crude protein diets on ruminal fermentation, omasal flow, and production in cows

**T. Mutsvangwa,[1] D. Kiran,[2] and S. Abeysekara**
Department of Animal and Poultry Science, University of Saskatchewan, Saskatoon, SK, Canada, S7N 5A8

## ABSTRACT

The objective of this study was to determine the effects of feeding canola meal (CM) or wheat dried distillers grains with solubles (W-DDGS) as the major source of protein in diets varying in crude protein (CP) content on ruminal fermentation, microbial protein production, omasal nutrient flow, and production performance in lactating dairy cows. Eight lactating dairy cows were used in a replicated 4 × 4 Latin square design with 29-d periods (21 d of dietary adaptation and 8 d of measurements) and a 2 × 2 factorial arrangement of dietary treatments. Four cows in 1 Latin square were ruminally cannulated to allow ruminal and omasal sampling. The treatment factors were (1) source of supplemental protein (CM vs. W-DDGS) and (2) dietary CP content (15 vs. 17%; DM basis). Diets contained 50% forage and 50% concentrate, and were fed twice daily at 0900 and 1600 h as total mixed rations for ad libitum intake. Dry matter intake and milk yield were unaffected by dietary treatments; however, milk yield in cows that were fed CM was numerically greater (+1.1 kg/d) when compared with cows fed W-DDGS. Feeding CM increased milk lactose content compared with feeding W-DDGS. Milk urea nitrogen and ruminal $NH_3$-N concentrations were greater in cows fed the high-CP compared with those fed the low-CP diet. The rumen-degradable protein supply was greater in cows fed the high-CP when compared with those fed the low-CP diet when diets contained CM, whereas rumen-degradable protein supply was lower in cows fed the high-CP when compared with those fed the low-CP diet when diets contained W-DDGS. Total N flow at the omasal canal was not affected by diet; however, omasal flow of $NH_3$-N was greater in cows fed CM when compared with those fed W-DDGS. The rumen-undegradable protein supply was greater in cows fed the low-CP when compared with those fed the high-CP diet when diets contained CM, whereas rumen-undegradable protein supply was lower in cows fed the low-CP when compared with those fed the high-CP diet when diets contained W-DDGS. Omasal flow of fluid-associated bacteria was greater and that of particle-associated bacteria tended to be greater in cows fed CM when compared with those fed W-DDGS; however, omasal flow of total microbial nonammonia N was unaffected by dietary treatment. Omasal flows of threonine and tryptophan were greater, whereas that of histidine and lysine tended to be greater in cows fed CM when compared with those fed W-DDGS. Our results show that when dairy diets are formulated to contain 15 or 17% CP, CM or W-DDGS can be used as the major source of protein and achieve similar levels of milk production.

**Key words:** dairy cow, wheat-based dried distillers grains with solubles, canola meal, nutrient supply, milk production

## INTRODUCTION

Traditionally, dairy cow diets in western Canada and parts of the United States typically contain canola meal (**CM**) as the principal source of protein because it is readily available and is a good quality protein supplement (Hickling, 2008; Mulrooney et al., 2009). Solvent-extracted CM contains high concentrations of CP (range of 40 to 44%; DM basis) and lysine (range of 4.88 to 5.56% of CP; Newkirk, 2009; Maxin et al., 2013a), thus making it well-suited for use as a protein supplement for dairy cows. Not surprisingly, numerous studies have been conducted to compare lactational performances of dairy cows fed CM as a substitute for other sources of protein, such as soybean meal (e.g., Brito and Broderick 2007; Christen et al., 2010; Broderick et al., 2015). In a meta-analysis of milk production responses to substituting CM for other protein supplements in dairy cow diets, Martineau et al. (2013) concluded that milk production in cows fed CM was

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[1]Corresponding author: tim.mutsvan@usask.ca.
[2]Current address: Evonik (SEA) Pte. Ltd., 3 International Business Park, #07-18 Nordic European Centre, Singapore 609927.

usually greater than that observed in cows fed other protein supplements.

Conversely, major growth of the ethanol industry in western Canada using wheat as the principal feedstock has resulted in large quantities of wheat-based dried distillers grains with solubles (**W-DDGS**) being available as an alternative protein supplement for dairy cows. When compared with CM, W-DDGS contains less CP (37.2%) and is a poorer source of lysine (2.53% of CP; Maxin et al., 2013a), suggesting that feeding W-DDGS as the major source of protein in place of CM could potentially compromise milk and milk protein yields due to a deficiency in lysine supply. To our knowledge, only one published study (Chibisa et al., 2012) has directly compared CM and W-DDGS as the major sources of supplemental protein in dairy cows fed barley-based diets that are typical of western Canada. Chibisa et al. (2012) reported that cows fed diets containing W-DDGS had greater milk yields when compared with those fed CM, a response that was attributed to greater DMI with W-DDGS. A potential shortcoming of that study was that experimental diets contained nearly 19% CP; consequently, even if dietary lysine content was lower in diets containing W-DDGS compared with CM, the omasal flows of lysine were similar and met requirements. From an environmental standpoint, feeding high-CP diets poses a risk due to the excretion of large amounts of N and it is now common to feed diets with 15 to 17% CP on dairy farms in western Canada (Chibisa and Mutsvangwa, 2013).

An in situ study conducted by Maxin et al. (2013a) indicated that the ruminal CP degradability of W-DDGS was higher than that of CM (53.2 vs. 47.5%). Because of the differences in RDP content of these 2 protein supplements, feeding either as the major source of dietary protein could have differential effects on ruminal microbial protein production. In addition to the source of dietary protein, dietary CP content can also have major effects on RDP supply, as the amount of dietary CP that is degraded in the rumen increases with dietary CP content (Colmenero and Broderick, 2006a). When dietary CP content is altered in diets containing either W-DDGS or CM as the major protein sources, the effect on RDP supply might be different due to differences in RDP content between CM and W-DDGS. Therefore, it is important to determine how changing dietary CP content and RDP supply interact to alter N utilization and production responses in diets containing CM or W-DDGS as the major source of protein. For the present study, our hypothesis was that at similar dietary CP content differences in the RDP content between CM and W-DDGS would result in differences in ruminal N utilization and omasal nutrient flows. Therefore, our objective was to determine the effects of feeding CM or W-DDGS as the major source of protein in diets containing 15 or 17% CP on ruminal fermentation, microbial protein production, omasal nutrient flow, and production performance in lactating dairy cows.

## MATERIALS AND METHODS

### Animals and Experimental Design

Eight multiparous Holstein cows (710 ± 60 kg of BW; 109 ± 36 DIM) were used in a replicated 4 × 4 Latin square design with a 2 × 2 factorial arrangement of treatments. Four cows in 1 Latin square were ruminally cannulated to allow ruminal and omasal sampling. The first 21 d of each period were used for dietary adaptation and the last 8 d for data and sample collection. Throughout the experiment, cows were housed individually in tiestalls at the Greenbrae Dairy Research Facility (University of Saskatchewan). Experimental cows were cared for and handled in accordance with the Canadian Council of Animal Care (1993) regulations and their use in this experiment was approved by the University of Saskatchewan Animal Care Committee (UCACS Protocol No. 20040048).

### Experimental Treatments and Feeding Management

The treatment factors that were tested were the source of supplemental protein (CM vs. W-DDGS) and dietary CP content (15 vs. 17%; DM basis). For diets with the same CP content, the inclusion rates of CM and W-DDGS were similar (Table 1). Single batches of CM and W-DDGS were used for the entire study. Within each CP level, the inclusion rates of CM and W-DDGS were similar by design. Because W-DDGS and CM differ in their CP contents, it was necessary to include small amounts (relative to the inclusion rates of CM and W-DDGS) of soybean meal and corn gluten meal to make diets isonitrogenous at each CP level. When dietary CP level was increased from 15 to 17%, however, the additional CP came primarily from CM and W-DDGS and also from higher inclusion levels of soybean meal and corn gluten meal. Because we wanted the inclusion levels of CM and W-DDGS to be similar, it was not possible to maintain similar levels of inclusion for soybean meal and corn gluten meal across CP levels. Even though the inclusion levels of soybean meal and corn gluten meal were different, it should be noted that all diets contained the same supplemental sources of protein, which would provide similar profiles of AA. Experimental diets were fed twice daily at 0900 and 1600 h as TMR for ad libitum intake. The forage-to-concentrate ratio of the TMR was 50:50, with