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Replacing alfalfa hay with dry corn gluten feed and Chinese wild rye grass: Effects on rumen fermentation, rumen microbial protein synthesis, and lactation performance in lactating dairy cows

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ABSTRACT

This experiment was conducted to investigate nutrient digestibility, rumen microbial protein synthesis, and lactation performance when a portion of alfalfa was replaced with combinations of dry corn gluten feed (DCGF) and Chinese wild rye grass in the diet of lactating cows. Six multiparous and 3 primiparous Chinese Holsteins were arranged in a replicated 3 × 3 Latin square experiment for 21-d periods. The animals were fed 1 of 3 treatment diets during each period: (1) 0% DCGF (0DCGF); (2) 6.5% DCGF (7DCGF); and (3) 11% DCGF (11DCGF). Diets were isonitrogenous, and a portion of alfalfa hay was replaced with DCGF and Chinese wild rye grass, with similar concentrate mixtures and corn silage contents. The dry matter intake was greater for 11DCGF (21.9 kg/d) than for 0DCGF (20.7 kg/d) or 7DCGF (21.2 kg/d). The treatment diets did not result in difference in milk production, fat and lactose concentration, or yield. Compared with 0DCGF, the ration containing 11% DCGF improved the milk protein concentration. Dry matter and neutral detergent fiber digestibility was greater for 7DCGF (62.7% and 45.6%) and 11DCGF (63.1% and 47.2%) than for 0DCGF (59.4% and 42.3%), and the nitrogen digestibility was similar for the 3 treatments. The concentration of rumen volatile fatty acids was higher in cows fed the 11DCGF diet than in those fed the 0DCGF diet, with no difference between the 7DCGF and 11DCGF diets. The estimated microbial crude protein yield was greater for the 11DCGF diet (1985.1 g/d) than for the 0DCGF diet (1745.0 g/d), with no difference between the 0DCGF and 7DCGF diets. Thus, it appears that feeding DCGF and Chinese wild rye grass in combination can effectively replace a portion of alfalfa hay in the rations of lactating dairy cows.

Key words: dry corn gluten feed, lactating performance, nutrient digestibility, purine derivative

INTRODUCTION

Alfalfa is an excellent forage used for dairy cattle (Viands et al., 1988), but the availability of this feed ingredient in the global herbivorous animal industry is limited. The quantity of alfalfa cannot meet the needs of dairy industry, and the gap between high-quality forage supply and demand is increasing rapidly, especially in China (Zhu et al., 2013). Therefore, the imported volume of alfalfa hay increases year by year, which increases feeding costs and decreases the economic benefits of the dairy industry. In contrast, large amounts of fibrous co-product are produced each year, with low lignin content and a large proportion of potentially digestible fiber, which may be used as fiber feed for dairy cows to replace a portion of alfalfa hay.

Corn gluten feed (**CGF**) is a co-product of the wet milling process and includes bran and steep (Bothast and Schlicher, 2005). It has approximately 1.91 Mcal NE/kg DM, which is similar to corn, and 45 to ~50% NDF, which is similar to many forages (NRC, 2001). Additionally, it contains highly digestible corn fiber and is high in CP (Kelzer et al., 2008). These qualities are desirable in feedstuffs for lactating cows. The bran is then mixed with steep liquor and stored as wet corn gluten feed (**WCGF**) or with water removed as dry corn gluten feed (**DCGF**). However, the WCGF is corruptible and should be stored in a sealed structure to reduce spoilage. Thus, the texture of the WCGF restricts flow and makes handling difficult. However, DCGF is available as flakes or pellets, it is easier to store and transport, and the feed is more available to a greater number of dairy farms than WCGF. Available research data in terms of using DCGF as a nonforage source to substitute for high-quality forages in dairy cow diets are less common. Firkins et al. (1991) reported that a 20% DCGF and 1% sodium bicarbonate combination was a commendable replacement for corn silage for dairy cows. VanBaale et al. (2001) reported

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that replacing a portion of alfalfa hay, corn silage, and corn grain with WCGF resulted in higher DMI and production efficiency. Farran et al. (2006) determined that WCGF could be used as an energy source to reduce the need for alfalfa hay. Cattle on diet that received WCGF with the removal of alfalfa hay from their diet had an increase in DMI, as well as improved carcass characteristics. Biricik et al. (2007) suggested that when 18 and 25% of the corn silage was replaced by DCGF, rumination time, chewing activities, and ruminal pH were negatively affected. The optimum level for the addition of DCGF was found to be below 18% of the diet for a healthy rumen and chewing behavior in dairy cows. In addition, replacing feedstuffs low in CP, such as corn grain or silage, with DCGF, which is high in CP, may result in higher concentrations of CP in rations, potentially increasing N excretion (Broderick, 2003; Groff and Wu, 2005). The digestible fiber from DCGF may supply the ruminal microbes with readily fermentable energy and promote microbial CP (**MCP**) synthesis (Calsamiglia et al., 2008). The AA profile of MCP is a close match to the animal's requirements and is believed to be highly digestible (Clark et al., 1992; NRC, 2001). Nonforage sources of fiber do not stimulate rumination activity as effectively as dietary forage because of their small particle size (Mertens, 1997). Allen and Grant (2000) reported that the physically effective NDF of CGF was 11% of NDF on the basis of rumination time and ruminal pH. Therefore, it is important to consider the combination of DCGF and long fiber feeds when it is used in the ration of lactating cows. Chinese wild rye grass is a type of gramineous forage grass in northeast China, and it is commonly used in dairy farms.

The objective of this research was to determine the effects on the digestibility of feed, MCP synthesis, and lactating performance when a portion of alfalfa hay was replaced with DCGF and Chinese wild rye grass in the diets of lactating Holstein cows.

MATERIALS AND METHODS

Animals, Diets, and Experimental Design

The use and care of the animals in this study were approved by the Animal Care Advisory Committee, Northeast Agricultural University (Harbin, China), and all the experimental procedures in this study were in accordance with the university's guidelines for animal research. The experimental animals were provided by the Comprehensive Breeding Farm (Harbin, China). Six multiparous and 3 primiparous Holsteins (BW = 596 ± 46.0 and DIM = 91 ± 22.8; mean ± SD) were used in a replicated 3 × 3 Latin square experiment with 21-d periods (14 d of diet adaption and 7 d of sample collection). Groups were balanced for parity and production and consumed 1 of 3 treatment diets during each period. The treatment diets contained similar concentrate mixtures and corn silage, but different proportions of roughage and DCGF. The treatments were (1) 0% DCGF (**0DCGF**); (2) 6.5% DCGF (**7DCGF**); and (3) 11% DCGF (**11DCGF**). The ration ingredient composition is shown in Table 1. Three isonitrogenous diets were formulated to meet the animals' requirements for energy, protein, minerals, and vitamins based on Cornell-Penn-Miner (Boston et al., 2000). Given the high level of NDF and CP contained in DCGF, it was combined Chinese wild rye grass and replaced portions of alfalfa hay. Chinese wild rye grass in rations ensured the requirement of effective fiber. Cows were housed in individual stall barns and fed twice daily (0600 and 1630 h) at 105% ad libitum intake, and milked twice daily at 0630 and 1830 h. The cows had free access to drinking water.

Table 1. Ingredients and chemical composition[1] (% of DM) of experimental diets

	Treatment[2]		
Item	0DCGF	7DCGF	11DCGF
Ingredient			
Alfalfa hay	23.4	13.4	5.94
Dry corn gluten feed	0	6.5	11.0
Chinese wild rye grass	0	3.5	6.46
Corn silage	23.3	23.3	23.3
Ground corn	22.32	22.32	22.32
Soybean meal	11.5	11.5	11.5
Cottonseed meal	7.73	7.73	7.73
DDGS[3]	4.6	4.6	4.6
Beet pulp	4.22	4.22	4.22
Sodium bicarbonate	0.5	0.5	0.5
Ca salts of long-chain fatty acids	1.4	1.4	1.4
Limestone	0.38	0.38	0.38
Salt	0.12	0.12	0.12
Premix[4]	0.53	0.53	0.53
Chemical composition			
CP	18.0	17.8	17.7
NDF	32.5	33.7	34.4
ADF	20.3	19.3	18.5
NFC[5]	36.5	37.1	35.3
Starch	21.2	21.4	21.5
NE_L,[6] Mcal/kg of DM	1.68	1.70	1.68

[1]Compositions of experimental diets were calculated according to the chemical analysis and inclusion rate of ingredients.

[2]0DCGF = 0% of DM dry corn gluten feed; 7DCGF = 6.5% of DM dry corn gluten feed; 11DCGF = 11% of DM dry corn gluten feed.

[3]DDGS = distillers dried grains with solubles.

[4]Premix contained (DM basis) 99.07% of ash, 14.27% of Ca, 5.42% of P, 4.96% of Mg, 0.05% of K, 10.67% of Na, 2.98% of Cl, 0.37% of S, 11 mg/kg of Co, 577 mg/kg of Cu, 4,858 mg/kg of Fe, 51 mg/kg of I, 1,806 mg/kg of Mn, 13 mg/kg of Se, 1,694 mg/kg of Zn, 115,240 IU/kg of vitamin A, 46,100 IU/kg of vitamin D, and 576 IU/kg of vitamin E.

[5]NFC = 100 − % NDF − % CP − % ether extract − % ash.

[6]Calculated based on MOA (2004).