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Effect of substituting soybean meal and canola cake with dried distillers grains with solubles at 2 dietary crude protein levels on feed intake, milk production, and milk quality in dairy cows

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ABSTRACT

Dried distillers grain with solubles (DDGS) is an alternative source of feed protein for dairy cows. Previous studies found that DDGS, based on grains other than corn, can substitute for soybean meal and canola cake as a dietary protein source without reducing milk production or quality. As societal concerns exist, and in many areas strict regulation, regarding nitrogen excretion from dairy cows, the dairy industry has focused on reducing dietary protein level and nitrogen excretion. In the present study, we investigated the use of DDGS as a protein source, at a marginally low dietary crude protein (CP) levels, in a grass-clover and corn silage-based ration. The experiment involved 24 Holstein cows and 2 protein sources (DDGS or soybean-canola mixture) fed at 2 levels of CP (14 or 16%) in a 4 × 4 Latin square design. The aim of this study was to evaluate the effect of both protein source and protein level on feed intake, milk yield, and milk quality. The results indicated that feed intake, milk yield, and protein in milk increased when the protein level in the ration was 16% CP compared with 14%. We found no effect of substituting the soybean-canola mixture with DDGS. Moreover, no sensory problems were observed when comparing fresh milk with stored milk, and milk taste was unaffected by DDGS. Milk from cows fed DDGS had a slightly higher content of linoleic acid and conjugated linoleic acid (CLA 9–11), and lower content of C11 to C17 fatty acids than cows fed diets with the soybean-canola mixture. Cows fed the diets with 16% CP produced milk with higher oleic acids and lower palmitic acid content than cows fed 14% CP diets. To conclude, DDGS can substitute for a soybean-canola mixture without affecting feed intake, milk yield and quality, or sensory quality. Under the conditions of this experiment, feeding 16% CP compared with 14% CP in the ration can increase feed intake and milk production.
Key words: coproduct, dried distillers grains with solubles, protein level, dairy cow

INTRODUCTION

Dried distillers grains with solubles (**DDGS**) has shown to be an alternative source of feed protein for dairy cows (Anderson et al., 2006; Janicek et al., 2008; Mjoun et al., 2010; Yildiz and Todorov, 2014). Corn and other grains (i.e., barley and wheat) are the predominant substrates used in the ethanol industry, from which DDGS is a co-product rich in protein and fiber and already widely used in dairy cow feeding (Anderson et al., 2006; Janicek et al., 2008; Chrenkova et al., 2012). Recently, it was shown that DDGS, based on a mixture of triticale, wheat, and barley, can substitute for soybean meal and canola cake as a dietary protein source without reducing milk production or milk quality when fed at 16.5% dietary CP (Gaillard et al., 2017). It is well known that both DMI and milk yield respond to dietary CP level in the range of 15 to 17% (Broderick, 2003). As societal concerns exist, and in many areas strict regulations, regarding nitrogen excretion from dairy cows, the dairy industry has focused on reducing dietary protein level and nitrogen excretion (Hynes et al., 2016a,b; Ouellet and Chiquette, 2016). Therefore, it is relevant to study whether DDGS, based on grains other than corn, can also substitute for standard protein sources such as soybean meal and canola cake at marginally low dietary CP levels. Broderick (2003) reported a linear increase in DMI when dietary CP was increased from 15.1 to 16.7 and 18.3%; however, milk yield only increased with the first CP increment, from

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33.0 to 34.1 kg/d, with no further change at 18.3% CP, resulting in lower feed efficiency (kg of milk/kg of DMI) at the highest CP level. Dried distillers grains with solubles have a lower concentration of potentially limiting AA, such as Lys, compared with traditional protein sources, such as soybean meal and canola cake (Oba et al., 2010), and there is also variation in Lys and protein content among different batches of DDGS (Belyea et al., 2010; De Boever et al., 2014). These differences in quality may negatively influence the value of DDGS as a protein feed at marginally low dietary CP levels. The efficiency of protein utilization will depend on the AA balance in the undegraded protein portion of the diet. Lys is the first limiting AA in a corn-based by-product (Nichols et al., 1998; Liu, 2008) and is susceptible to excessive heat during the preparation of DDGS (Kleinschmit et al., 2006). Dietary addition of ruminally protected Lys, and sometimes Met (second limiting AA), can, in some cases, increase milk yield of cows fed with corn-based DDGS (Kleinschmit et al., 2007a). The effect of substituting standard protein sources, such as soybean meal and canola cake, with DDGS is further influenced by heat treatment and, thereby, ruminal degradability of the protein in DDGS (Firkins et al., 1984; Kononoff et al., 2007; Boucher et al., 2009), by the protein quality of the forage, and the efficiency of rumen microbial protein production. In the present study, we investigated the use of DDGS, based on grains other than corn, at a marginally low dietary CP level in a grass-clover and corn silage-based ration. The experiment involved 2 dietary protein sources (DDGS or a soybean-canola mixture) at 2 levels of dietary CP (planned levels: 14 and 16% CP). Our aim was to evaluate the effect of protein source and protein level on DMI, milk yield, and milk quality.

MATERIALS AND METHODS

Experimental Facilities and Animals

The experiment was approved by The Animal Experiments Inspectorate under the Danish Veterinary and Food Administration (Glostrup, Denmark) and carried out from September to November 2013 at the Danish Cattle Research Centre at Aarhus University, Foulum, Denmark. A total of 24 Danish Holstein cows (8 primiparous cows, 16 multiparous cows) were included in the experiment, housed in a loose-housing system with slatted floors and cubicles with mattresses and sawdust as bedding. Cows had free access to water and to automatic feed bins (RIC system, Insentec, Marknesse, the Netherlands) distributing a partially mixed ration (**PMR**). The automatic milking unit (**AMU**; DeLaval AB, Tumba, Sweden) was equipped with a device delivering and recording the amount of concentrate fed and refusals.

Experimental Design

Four diets differing in level of CP and protein source were formulated and optimized using the NorFor model (Volden, 2011). Two diets with different levels of CP were formulated: a diet low in CP (**LP**, formulated to 14% CP) and one high in CP (**HP**, formulated to 16% CP). At each dietary CP level, DDGS (Agrodrank 90, Lantmännen Agroetanol, Sweden) based on 80% wheat and 20% triticale was substituted for a soybean-canola-beet pulp mixture (**MIX**), leading to 4 different PMR diets: LP-MIX, LP-DDGS, HP-MIX, and HP-DDGS. The ingredient composition (% of DM) and chemical composition of these 4 PMR diets are presented in Tables 1 and 2. The MIX diet was formulated to be approximately similar to DDGS in CP, fat, and NDF. Cows were blocked in 6 blocks of 4 cows according to parity, milk production, and DIM (average 228 ± 91 d). Within blocks, cows were randomly assigned to 1 of the 4 diets. Diets were fed for 3 wk, with 2 wk of adaptation and 1 wk of data collection. The diets were rotated according to a 4 × 4 Latin square design so that each group had a different diet at the same time. Each treatment group (6 cows) had access to all of the 3 feeders with the assigned ration. During diet rotation, the cows kept the same feeders to avoid a perturbation effect. The 4 PMR diets were fed ad libitum; only the concentrate mix allocated at the AMU was restricted (3 kg/d of concentrate). The concentrate allowance allocated at each visit in the AMS was proportional to the length of time since the last milking for the individual cow. Concentrate was offered at a rate of 400 g/min and cows were allowed up to 50% of the daily concentrate allowance per visit. If the full allowance was not fed, it was possible for cows to carry over up to 1.5 kg of concentrate to the next day.

Recordings

Individual daily DMI was summed from PMR, and AMU concentrate intake recorded at each visit to the Insentec feeder and the AMU. All feeds were sampled weekly and stored at −20°C until pooled, and a representative sample was drawn for chemical analyses. Individual milk yield was recorded at each visit to the AMU and summed to obtain daily milk yield. Daily milking frequency was also recorded. Individual milk samples were collected weekly by the AMU using a