J. Dairy Sci. 97:1–12
http://dx.doi.org/10.3168/jds.2013-7815


# Corn bran versus corn grain at 2 levels of forage: Intake, apparent digestibility, and production responses by lactating dairy cows

**C. Arndt,* L. E. Armentano,*[1] and M. B. Hall†**
*Department of Dairy Science, University of Wisconsin, Madison 53706
†US Dairy Forage Research Center, USDA Agricultural Research Service (ARS), Madison, WI 53706

## ABSTRACT

The objective of this study was to determine the effect of substituting corn bran (CB) for dried ground corn grain (CG) in the nonforage portion of high-forage (HF) and low-forage (LF) diets. Twelve multiparous and 12 primiparous Holsteins were assigned to 4 diets using six 4 × 4 Latin squares with 3-wk periods. Forage was 64 or 38% of the total mixed ration (% of dry matter). On a dry matter basis, the HFCG diet had 20% CG, the LFCG diet had 39% CG, the HFCB diet had 19% CB, and the LFCB diet had 38% CB. Digestible organic matter intake (OMI) and milk energy yield were lower for CB compared with CG within forage level. Digestible OMI was greater (1.9 kg/d) for the LFCG compared with the HFCG treatment. When CB replaced forage (LFCB vs. HFCB), digestible OMI was not different but milk energy yield was greater with the LFCB diet. The LFCG diet supported the greatest milk, milk protein, and milk energy yield. Decreased concentration of milk protein and increased concentration of milk urea nitrogen when feeding CB compared with CG suggests that lack of fermentable energy in the CB diets may have limited rumen microbial protein synthesis. Total substitution of CG with CB in the nonforage portion did not support maximum milk production, even when forage was reduced at the same time (HFCG vs. LFCB). Predicted neutral detergent fiber (NDF) digestibility at 1 times maintenance, based on chemical analysis of the individual feeds, was 22 percentage units greater for CB than for the forage mix (68.9 vs. 46.9%). In vitro NDF digestibility (30 h) was 19.4 percentage units greater for CB than for the forage mix (68.9 vs. 49.5%). However, in vivo NDF digestibility of the diet when CB replaced forage (HFCB vs. LFCB) was similar (44.1 vs. 44.5%). Similarly, predicted total digestible nutrients at the production level of intake, based on chemical analysis, were greater for the CB treatments and lower for the CG treatments than those observed in vivo.

**Key words:** corn bran, corn grain, fiber source

## INTRODUCTION

Feed costs are the largest part of the total production costs in dairy cattle operations. Using alternative, potentially less expensive feed sources that do not negatively affect total production and other performance measures may increase profitability. Within the alternative feed sources, attention should be given to coproducts from the corn ethanol industry because in 2013, the corn ethanol industry produced 84,088 t of livestock feed (RFA, 2014).

Corn ethanol is produced by the fermentation of corn starch. Different ethanol production processes produce a variety of coproducts. These coproducts contain mostly protein, fiber, and fat (RFA, 2008). The fiber is derived from the corn pericarp or corn bran (**CB**), the outer coating of the corn kernel (Watson, 2003). However, compared with corn grain (**CG**), grain milling or fermentation coproducts have a lower NFC and starch and higher NDF, CP, and ether extract (**EE**) content. Currently, the 2 major coproducts are corn gluten feed (35.5% NDF and 34.0% NFC; NRC, 2001) from wet milling, and distillers grains with solubles (38.8% NDF and 24.6% NFC; NRC, 2001) from the conventional dry grind process. Both wet corn gluten feed and distillers grains with solubles have been shown to successfully substitute for part of the forage mix or concentrate portion, or both, in dairy cow rations without detrimental effects on cow performance (Schingoethe et al., 2009; Ranathunga et al., 2010). Also, Janicek et al. (2007) observed no negative effect on lactating dairy cow performance when CB increased from 10 to 25% dietary DM, replacing forage. However, the feed denoted as CB contained relatively low NDF (30.4%) and high NFC (45%). Thus, the role of NDF in these coproducts cannot be evaluated from these studies because the NDF content of these coproducts was <40% of DM. Pure CB comprises predominantly NDF, as it comes from

Received December 10, 2013.
Accepted May 26, 2014.
[1]Corresponding author: learment@wisc.edu

the pericarp and tip cap of the CG, which contain 90 and 95% NDF (% of DM), respectively (Watson, 2003).

The objectives of the present study were to estimate the nutritional value of relatively pure CB compared with CG in the nonforage portion of the diet at 2 levels of forage [i.e., high forage (**HF**) and low forage (**LF**)], and thereby to evaluate the value of CB fiber relative to whole corn grain. These treatment arrangements also allowed comparison of CB replacing forage (HFCB vs. LFCB), and CB replacing a mixture of CG and forage (LFCB vs. HFCG). The effects of these treatments on performance, intake, and apparent total-tract digestibility of the diets were evaluated.

## MATERIALS AND METHODS

### Cows and Experimental Design

Twelve multiparous and 12 primiparous lactating Holstein cows, averaging 103 ± 14 (mean ± SD) DIM at the beginning of the experiment were used in a 4 × 4 Latin square design with 21-d periods. The 6 Latin squares were arranged as a randomized complete block in which cows were blocked by production (low, medium, and high) within parity (primiparous and multiparous) before assignment to a square. The 3 production levels were determined by using 305-d projected milk yield (DairyCOMP 305; Valley Agricultural Software, Tulare, CA). Within parity, 3 Latin squares with different treatment sequence patterns were used to balance for single-period carryover, with the same set of 3 squares used for both parity groups. However, production groups were randomized to squares and cows were randomized within squares. The 305-d projected milk yield for high, medium, and low cows was 25,346, 21,853, and 19,854 kg, respectively. All cows were injected with bST (500 mg of Polisac; Monsanto Co., St. Louis, MO) at 14-d intervals.

Cows were housed in individual tie-stalls and had free access to water throughout the experiment. Cows were milked twice daily at 1535 and 0435 h and milk weights were recorded. Care and handling of the animals was conducted under protocols approved by the University of Wisconsin-Madison College of Agricultural and Life Sciences Institutional Animal Care and Use Committee.

### Diets

Four diets with 2 different forage levels (HF or LF), supplemented with ground dried CG or CB in the nonforage portion of the diet were offered as TMR to the cows: HFCG, HFCB, LFCG, and LFCB (Table 1). The LF diet concentrate contained (DM basis) 55.9% CG or 53.9% CB, and the HF diet concentrate contained 63.8% CG or 61.5% CB. A larger absolute substitution of CB for CG in the LF diets was made due to a larger proportion of nonforage mix in the LF diets compared with the HF diets. The forage portion was 55% corn silage and 45% alfalfa silage for all diets. Proportions of feeds within the nonforage portion of the diet had to be altered between HF and LF diets to meet the requirements of the lactating cows. For the HFCG, LFCG, HFCB, and LFCB, the cottonseed proportion in the nonforage portion of the diet was similar (10.3, 9.8, 11.9, and 11.3%, respectively) as was distillers grains with solubles (2.5, 2.5, 2.9, and 2.9%, respectively). The soybean meal and blood meal portions of the nonforage portion of the diet were used to create rations similar in CP, RUP, and RDP content, based on evaluations made with the NRC (2001) model.

All cows were fed once daily at 0900 h. Animals were fed ad libitum and intakes were adjusted daily to achieve 10% refused feed. Average dietary chemical compositions are reported in Table 2. Diet chemical compositions were calculated based on diet feed ingredient composition and chemical analysis of individual feed samples for all components but RUP, RDP, $NE_L$, and diet mineral composition. Rumen-undegradable protein, RDP, and $NE_L$ contents were predicted using the NRC (2001) and observed intakes. Diet mineral composition was analyzed from 1 TMR composited for each diet across all 4 periods.

### External Markers

The external digestibility marker used was Yb (Prigge et al., 1981). Ytterbium was dosed over the last 10 d of each period via a Yb-marked soybean meal premix that was mixed into the TMR. A purchased $YbCl_3$ solution analyzed to contain 331 g of Yb/L by the supplier (Rhodia Inc., Phoenix, AZ) was diluted with distilled $H_2O$ to prepare Yb solutions containing 62 g of Yb/L. Each period, Yb-marked soybean meal was prepared by spraying a total of 6 L of Yb solution, using a hand-held sprayer (1 gal., model 71967; Ace Hardware Corp., Oak Brook, IL), on 170 kg (as fed) of soybean meal while being mixed in a Leeson feed mixer (model C6C17FB2F; Leeson Electric Corp., Grafton, WI). Ytterbium was delivered to the cows within the TMR by replacing part of the unmarked soybean meal (87.9% DM) with an equal weight (as fed) of the Yb-marked soybean meal (86.5% DM) in the TMR mixer. On the first day of marker dosing, approximately 1.5 g of Yb/cow was provided and the following days approximately 1.0 g Yb/cow was provided. The concentration of Yb was analyzed in a composite sample of each TMR for each period and in the composited feed refusals from each individual cow for each period. Intake of Yb of