J. Dairy Sci. 99:1–9
http://dx.doi.org/10.3168/jds.2015-10285
© American Dairy Science Association®, 2016.

# Feeding of wheat bran and sugar beet pulp as sole supplements in high-forage diets emphasizes the potential of dairy cattle for human food supply

**P. Ertl,*[1] Q. Zebeli,† W. Zollitsch,* and W. Knaus***
*Department of Sustainable Agricultural Systems, Division of Livestock Sciences, BOKU–University of Natural Resources and Life Sciences Vienna, 1180 Vienna, Austria
†Institute of Animal Nutrition and Functional Plant Compounds, Department for Farm Animals and Veterinary Public Health, University of Veterinary Medicine, 1210 Vienna, Austria

## ABSTRACT

Besides the widely discussed negative environmental effects of dairy production, such as greenhouse gas emissions, the feeding of large amounts of potentially human-edible feedstuffs to dairy cows is another important sustainability concern. The aim of this study was therefore to investigate the effects of a complete substitution of common cereal grains and pulses with a mixture of wheat bran and sugar beet pulp in a high-forage diet on cow performance, production efficiency, feed intake, and ruminating behavior, as well as on net food production potential. Thirteen multiparous and 7 primiparous mid-lactation Holstein dairy cows were randomly assigned to 1 of 2 treatments in a change-over design with 7-wk periods. Cows were fed a high-forage diet (grass silage and hay accounted for 75% of the dry matter intake), supplemented with either a cereal grain-based concentrate mixture (CON), or a mixture of wheat bran and dried sugar beet pulp (WBBP). Human-edible inputs were calculated for 2 different scenarios based on minimum and maximum potential recovery rates of human-edible energy and protein from the respective feedstuffs. Dietary starch and neutral detergent fiber contents were 3.0 and 44.1% for WBBP, compared with 10.8 and 38.2% in CON, respectively. Dietary treatment did not affect milk production, milk composition, feed intake, or total chewing activity. However, chewing index expressed in minutes per kilogram of neutral detergent fiber ingested was 12% lower in WBBP compared with CON. In comparison to CON, the human-edible feed conversion efficiencies for energy and protein, defined as human-edible output per human-edible input, were 6.8 and 5.3 times higher, respectively, in WBBP under the maximum scenario. For the maximum scenario, the daily net food production (human-edible output minus human-edible input) increased from 5.4 MJ and 250 g of crude protein per cow in CON to 61.5 MJ and 630 g of crude protein in the WBBP diet. In conclusion, our data suggest that in forage-based dairy production systems, wheat bran and sugar beet pulp could replace common cereal grains in mid-lactation dairy cows without impairing performance, while strongly increasing human-edible feed conversion efficiency and net food production index.
**Key words:** human-edible, feed conversion efficiency, nonforage fiber source, food security, by-product

## INTRODUCTION

Projected increases in the world's global food demand will increase public pressure on animal agriculture because, besides concerns about the environmental effects of livestock production, the generally low efficiency of converting feed nutrients into animal products is a major issue of criticism. Scientists have therefore pointed out the necessity of feeding less human-edible feeds to livestock in the future (FAO, 2011; Eisler et al., 2014), which could increase net food production (**NFP**), defined as human-edible output via animal products minus potentially human-edible input via feedstuffs. A recent evaluation of 30 Austrian dairy farms has shown that their average NFP is slightly positive for energy and protein, but that there is great potential for improvement (Ertl et al., 2015a). In the trade-off between feeding for high animal performance and reducing human-edible inputs at the same time, fiber-rich by-products offer promising opportunities, especially in terms of energy supply (Bradford, 1999; Gill, 2013). In fact, fiber-rich by-products have long been used in dairy cattle nutrition, both as alternative feedstuffs to forage, or as alternative fiber [nonforage fiber sources (**NFFS**)] and energy sources for high-yielding dairy cattle (Swain and Armentano, 1994; Bradford and Mullins, 2012; Dann et al., 2014). However, data on NFFS usage in high-forage diets, as well as quantitative data on the potential of NFFS to increase NFP and human-edible feed conversion efficiency (**heFCE**), are limited. The heFCE expresses the human-edible output through the animal product per human-edible input in feedstuffs.

Received August 19, 2015.
Accepted November 3, 2015.
[1]Corresponding author: paul.ertl@boku.ac.at

In an earlier feeding trial, we substituted a mixture of industrial by-products for a mixture of commonly used concentrates as energy and protein sources and found that this substitution could increase the human-edible feed conversion efficiency by 4 and 2.7 times for energy and protein, respectively, without impairing milk production (Ertl et al., 2015b). However, the by-products included in this earlier trial were still rich in $NE_L$ and CP (to achieve an isoenergetic and isonitrogenous experimental diet), which is most likely not true for the majority of common by-products that are available in large quantities.

With an annual production of nearly 3 million tonnes of sugar beets and close to 1.5 million tonnes of wheat, these were 2 of the top 5 commodities produced in Austria in 2013. With an annual production of nearly 250 million tonnes of sugar beets and over 600 million tonnes of wheat worldwide, these commodities are also among the most commonly cultivated crops around the world (FAO, 2015). During processing of sugar beets and wheat, about 20% of the DM results in the by-products sugar beet pulp and wheat bran, respectively, which indicates their high availability (Fadel, 1999). Whereas several studies have investigated the use of sugar beet pulp in dairy cow diets (Bhattacharya and Lubbadah, 1971; Hemingway et al., 1986; Voelker and Allen, 2003), only limited information is available for wheat bran. In a recent study, Dann et al. (2014) formulated lower-starch diets by partially replacing corn with sugar beet pulp and wheat middlings and did not find measurable effects on ruminal fermentation, chewing behavior, or milk performance. However, in Dann et al. (2014), grass silage plus hay accounted for only 23.5% of the diet DM, whereas this is usually well over 50% for typical Austrian dairy rations. Replacing concentrates with NFFS in less fermentable diets, however, might reduce DMI and productivity (Bradford and Mullins, 2012).

Therefore, the objective of the current study was to examine the effect of feeding a mixture of wheat bran and sugar beet pulp as sole dietary supplements in a high-forage diet for mid-lactation dairy cows. We hypothesized that replacing the grain concentrate portion in a high-forage diet (75% of total DMI) with wheat bran and sugar beet pulp would not impair milk performance data, DMI, or chewing activity in low-performing dairy cows, but we expected strong effects on NFP and efficiency indicators.

## MATERIALS AND METHODS

### Experimental Design and Animals

Thirteen multiparous and 7 primiparous Holstein cows were used in an experiment conducted as a change-over design with 2 consecutive experimental periods of equal duration (7 wk each). Cows were housed in a cubical housing system with Calan gates (American Calan Inc., Northwood, NH) for individual feeding at the organic dairy farm of the Secondary Agricultural and Forestry School Ursprung in the province of Salzburg, Austria (570 m above sea level, 1,250 mm annual precipitation, 8.5°C average annual temperature). At the beginning of the experiment, cows were randomly assigned to 1 of 2 treatment groups of 10 cows each, according to their average (±SD) milk yield (26.2 ± 6.0 kg), BW (661 ± 54 kg), DIM (117 ± 113), and number of lactations (3.1 ± 2.4).

Prior to the experiment, all cows were fed grass silage, corn silage, and hay derived from permanent grassland at a ratio of approximately 0.75:0.15:0.10 on a DM basis for ad libitum intake. In addition, cows received a mixture of commercially produced concentrates in pelleted form via an automatic feeding station depending on the milk yield of the previous week (up to a maximum rate of 8 kg/d). Cows were allowed to adapt to the respective diet during the first 2 wk of each experimental period and measurements were taken in each period between wk 3 and 7. Immediately after the end of the first experimental period, the treatment groups were switched and the adaptation period for the second period began. The week before the start of the first experimental period served as adaptation time for Calan gates. No invasive procedures were performed on the animals and the provincial veterinary authority Salzburg approved the feeding trial.

### Diets and Feeding Procedure

Two TMR differing in the type of concentrate were compared in this experiment. The TMR were prepared once a day and offered twice daily (0500 and 1500 h) in an amount to ensure 5 to 10% feed refusals. Composition of the 2 different diets, as well as the estimated potentially human-edible fraction of each ingredient (Ertl et al. 2015a), are shown in Table 1. Dietary treatments were not formulated to be isoenergetic or isonitrogenous, but to obtain the same forage-to-concentrate ratio of 0.75:0.25 on a DM basis. Forage for both diets consisted of first-cut grass silage, and second and third-cut hay (different cuts of hay at equal proportions). About 50% of the forages (hay and silage) were derived from permanent grassland (composition approximately 50% grasses, 30% herbs, and 20% legumes) and the other 50% from perennial clover-grass (about 50% grasses and 50% clover). In addition to forage, the control diet (**CON**) included a commercially produced concentrate mixture, commonly used in Austrian organic dairy production (Table 1). The experimental

Download English Version:

https://daneshyari.com/en/article/10973554

Download Persian Version:

https://daneshyari.com/article/10973554

Daneshyari.com