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Variation in nutrients formulated and nutrients supplied on 5 California dairies

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ABSTRACT

Computer models used in ration formulation assume that nutrients supplied by a ration formulation are the same as the nutrients presented in front of the cow in the final ration. Deviations in nutrients due to feed management effects such as dry matter changes (i.e., rain), loading, mixing, and delivery errors are assumed to not affect delivery of nutrients to the cow and her resulting milk production. To estimate how feed management affects nutrients supplied to the cow and milk production, and determine if nutrients can serve as indexes of feed management practices, weekly total mixed ration samples were collected and analyzed for 4 pens (close-up cows, fresh cows, high-milk-producing, and low-milk-producing cows, if available) for 7 to 12 wk on 5 commercial California dairies. Differences among nutrient analyses from these samples and nutrients from the formulated rations were analyzed by PROC MIXED of SAS (SAS Institute Inc., Cary, NC). Milk fat and milk protein percentages did not vary as much [coefficient of variation (CV) = 18 to 33%] as milk yield (kg; CV = 16 to 47 %) across all dairies and pens. Variability in nutrients delivered were highest for macronutrient fat (CV = 22%), lignin (CV = 15%), and ash (CV = 11%) percentages and micronutrients Fe (mg/kg; CV = 48%), Na (%; CV = 42%), and Zn (mg/kg; CV = 38%) for the milking pens across all dairies. Partitioning of the variability in random effects of nutrients delivered and intraclass correlation coefficients showed that variability in lignin percentage of TMR had the highest correlation with variability in milk yield and milk fat percentage, followed by fat and crude protein percentages. But, variability in ash, fat, and lignin percentages of total mixed ration had the highest correlation with variability in milk protein percentage. Therefore, lignin, fat, and ash may be the best indices of feed management to include effects of variability in nutrients on variability in milk yield, milk fat, and milk protein percentages in ration formulation models.
Key words: nutrient variability, ration formulation variability, milk production variability

INTRODUCTION

How much effect nutrient variability has on variability in milk production is unknown. But, it is known that increasing nutrient variability decreases milk production (Friggens et al. 1995; Stone, 2008; Weiss et al., 2012). It is generally accepted that at least 5 rations are possible on a dairy. The first is the ration that is formulated to meet the cow or pen requirements; the second is the ration that is entered into the feed management software, complete with current DM values; the third is the ration that is loaded into the feed wagon; the fourth is the ration that is delivered to the cows; and the fifth is the ration that the cows eat. At each stage of creating the final ration, variation in nutrient content of the ration will increase and be affected by feed management (Kertz, 1998). The computer diet may be altered to reflect current feed prices and inventory without reformulation, DM contents may not be up to date with current weather and storage conditions, feed wagon or loader weigh cells may not be calibrated correctly, feed wagons may not be well maintained, and errors associated with weighing, mixing feed ingredients, and unloading rations will affect the supply of nutrients delivered to cows. Cows will sort feed ingredients and ingredient intake will be affected by the order in which the cows approach the feed bunk. Endres and Espejo (2010) described the interaction among feeding management and ration characteristics and compared DM, NDF, and CP content of the analyzed ration to the formulated ration from bunk samples. They found an association between changes in NDF content over time (due to sorting) and low milk production, which was probably due to herds with poorer feed management, indicating that variability in NDF could contribute to decreased milk production

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but it could also be confounded with herds with higher NDF in the TMR. Huzzey et al. (2013) examined the effect of variation in energy density in TMR on feeding behavior of dairy heifers and determined that increased variation in energy density across the feed bunk and across days changed the eating behavior of the heifers and increased changes in feeding locations and competitive behavior at the feed bunk, also increasing variability in performance. Variability in nutrient content of the ration affects performance and consistency of nutrients supplied to the cows and is a direct reflection of feed management practices. Therefore, variability in individual nutrients may serve as a useful index of the effect of feed management practices on nutrients supplied to dairy cows that can be included in ration formulation.

Current models and ration formulation packages do not take feed management factors into consideration in ration formulation (Sniffen et al., 1993; Bach et al., 2008). Models predict nutrient requirements of an individual cow without consideration of variability among cows within a pen or variation due to feed management (Pecsok et al., 1992). In addition, feed libraries associated with ration formulation packages will also affect nutrient content of the rations, as feed ingredients that are not routinely analyzed (i.e., book values) may not be representative of local feed ingredient nutrient compositions (Sniffen et al., 1993; Kertz, 1998; Endres and Espejo, 2010). How dairy cattle are fed, quality control of feeds, feed mixing, and loss of feed sources due to spoilage, loading, weather, and so on, affect the health and production of dairy cattle and profitability of a dairy (Sniffen et al., 1993; Bach et al., 2008). The purpose of the current research was to quantify the relationship between variation in milk production and TMR nutrient variation to examine its use as an index of feed management for ration formulation. Therefore, the objectives of this research were to (1) quantify variability in TMR nutrients supplied to and milk produced by cows for each dairy, (2) compare variability among TMR nutrients from the nutritionist formulation, laboratory analyses, and nutrients calculated from TMR ingredients loaded into the mixer wagon using the NRC (1989, 2001) guidelines or the nutritionist feed library within the ration formulation program to determine the importance of using laboratory analyses to evaluate rations, and (3) identify which nutrient variability increases variability in milk production, thus possibly serving as an index of feed management.

MATERIALS AND METHODS

Data from 5 commercial dairies located in Tulare and Kings Counties (California) was used in this study and are described in Tables 1 and 2. All dairies have feed management software: either EZfeed (DHI-Provo, Provo, UT) or FeedWatch (Valley Ag Software, Tulare, CA). Total mixed ration samples, feed management data, and milk production data were collected from 4 pens at each dairy, representing close-up cows (3 wk or less before calving), fresh cows (3 to 30 DIM), high-producing cows (30 to 150 DIM), and if possible, low-producing cows (>150 DIM) in fall 2010 and summer 2011. Therefore, pen is considered the experimental unit of interest. Monthly milk test data was downloaded from DHI-Plus software (DHI-Provo) or DairyCOMP software (Valley Ag Software) for at least 2 test days during the time of TMR sample collection. Dairy 1 was sampled in 2010, dairies 2 and 3 were sampled in both years, and dairies 4 and 5 were sampled in 2011. Milk fat percentage and (or) milk protein percentage data were not available from dairy 4 and dairy 2 because these dairies do not include milk protein and milk fat in their DHIA testing. Therefore, they were excluded from

Table 1. Description of dairies[1]

	Dairy				
Item	1	2	3	4	5
Dates sampled	Oct. 21, 2010 to Nov. 29, 2010	Nov. 17, 2010 to Jan. 19, 2011; Aug. 1, 2011 to Sep. 26, 2011	Oct. 7, 2010 to Nov. 16, 2010; Jul. 28, 2011 to Oct. 13, 2011	Jul. 26, 2011 to Sep. 27, 2011	Jul. 25, 2011 to Sep. 26, 2011
Facilities	Freestall	Dry lot	Freestall	Freestall	Dry lot
Feed management software[2]	FeedWatch	EZfeed	FeedWatch	FeedWatch	EZfeed
Number of milking cows	916	2,269	3,208	5,128	3,093
Average DIM	195 (56)	166 (67)	189 (60)	181 (61)	187 (64)
Herd milk yield (kg/cow per day)	30 (33)	32 (30)	35 (29)	39 (25)	32 (28)
Herd protein (%)	3.5 (20)		3.1 (12)		3.2 (8.4)
Herd fat (%)	3.1 (11)	3.6 (18)	3.6 (23)		3.6 (14)

[1]Means [CV (%) in parentheses].

[2]FeedWatch (Valley Ag Software, Tulare, CA); EZfeed (DHI-Provo, Provo, UT).