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RESEARCH ARTICLE

Accuracy comparison of dry matter intake prediction models evaluated by a feeding trial of lactating dairy cows fed two total mixed rations with different forage source



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Abstract

Dry matter intake (DMI) prediction models of NRC (2001), Fox *et al.* (2004) and Fuentes-Pila *et al.* (2003) were targeted in the present study, and the objective was to evaluate their prediction accuracy with feeding trial data of 32 lactating Holstein cows fed two total mixed rations with different forage source. Thirty-two cows were randomly assigned to one of two total mixed ration groups: a ration containing a mixed forage (MF) of 3.7% Chinese wildrye, 28.4% alfalfa hay and 26.5% corn silage diet and another ration containing 33.8% corn stover (CS) as unique forage source. The actual DMI was greater in MF group than in CS group ($P=0.064$). The NRC model to predict DMI resulted in the lowest root mean square prediction error for both MF and CS groups (1.09 kg d^{-1} vs. 1.28 kg d^{-1}) and the highest accuracy and precision based on concordance correlation coefficient for both MF and CS diet (0.89 vs. 0.87). Except the NRC model, the other two models presented mean and linear biases in both MF and CS diets when prediction residuals were plotted against predicted DMI values ($P<0.001$). The DMI variation in MF was caused by week of lactation (55.6%), milk yield (13.9%), milk fat percentage (7.1%) and dietary neutral detergent fiber (13.3%), while the variation in CS was caused by week of lactation (50.9%), live body weight (28.2%), milk yield (8.4%), milk fat percentage (5.2%) and dietary neutral detergent fibre (3.8%). In a brief, the NRC model to predict DMI is comparatively acceptable for lactating dairy cows fed two total mixed rations with different forage source.

Keywords: dairy cows, dry matter intake, model comparison, mixed forage, corn stover

1. Introduction

An accurate prediction of feed intake is essential to meet nutrient requirements of dairy cows to achieve their optimum performance, and it's also important for diets formulation to optimize milk production without compromising animal welfare (NRC 2001). The NRC model to predict dry matter intake (DMI) was mainly developed for high yielding Holstein Friesian cows fed diets containing a large proportion of

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concentrate and maize silage (Zom *et al.* 2012b), and it is applicable only in intensive dairy farms in China. However, the small- and medium-sized dairy farms in China usually choose the easily available and cheap corn stover as the roughage to reduce feed cost. Because the NRC model was built based on diets without corn stover, the difference in roughage sources between NRC model and diets with corn stover as sole forage may lead to incorrect DMI prediction. Hence, the prediction accuracy of NRC model needed to be evaluated when corn stover as unique roughage source.

DMI can be affected not only by animal factors such as body condition, physiological stage and productivity, but also by dietary factors including chemical composition, nutritive value and physical properties (Roseler *et al.* 1997a; Hayirli *et al.* 2002). It was suggested that dietary and environmental factors should be incorporated into DMI prediction models (Fuentes-Pila *et al.* 2003; Fox *et al.* 2004; Huhtanen *et al.* 2011; Zom *et al.* 2012a). Therefore, determination of animal and dietary factors affecting DMI and accuracy evaluation of DMI models that integrated animal and dietary factors are important to improve the feeding strategies of dairy industry in China.

The one purpose of this study was to find out the main animal and dietary factors affecting DMI when dairy cows fed diet with mixed forage or corn stover as sole roughage. Another purpose was to evaluate the accuracy of three widely used models when lactating cows were offered diets containing mixed forage or corn stover.

2. Materials and methods

2.1. Animal management

Animal care and procedures were in accordance with the Chinese guidelines for animal welfare and approved by Animal Care and Use Committee of Chinese Academy of Agricultural Sciences. Thirty-two lactating Holstein cows in their second or third parity (means±SD, Age=3.70±0.13; Body weight=(520.07±32.99) kg; Body condition score=2.60±0.56; Days in milk=(15±4) d; Average daily milk yield=(19.45±2.31) kg d⁻¹) were randomly assigned to one of two groups and fed either a mixed forage (MF) diet or corn stover as unique forage (CS) diet using a randomized block design. The CS diet included 33.8% corn stover, while the MF diet included 3.7% Chinese wildrye, 28.4% alfalfa hay and 26.5% corn silage (dry matter basis). Ingredient and nutrient composition of the diets are presented in Table 1. The experiment was conducted from 28 December, 2011 to 29 November, 2012. Throughout the experimental period, all cows were fed individually and housed in a tie-stall barn. Total mixed rations were supplied twice daily at 0730 and 1930 h, and

Table 1 Ingredients and chemical composition of corn stover (CS) and mixed forage (MF) offered to lactating dairy cows

Item	Mixed forage (MF) ration ³⁾	Corn stover (CS) ration ⁴⁾
Ingredient (% , DM basis)		
Chinese wildrye grass hay	3.70	–
Corn stover	–	33.80
Alfalfa hay	28.40	–
Corn silage	26.70	–
Corn meal	22.80	21.70
Wheat bran	–	4.00
Soybean meal	11.80	3.30
Whole cottonseeds	5.10	–
Cottonseed meal	–	2.60
Corn gluten lipid	–	9.90
Corn gluten meal	–	11.90
Calcium phosphate	0.60	0.70
Distillers dried grains with soluble	–	9.30
Zeolite	–	0.70
Limestone	–	1.10
NaCl	0.50	0.70
Premix ¹⁾	0.60	0.30
Total	100	100
Chemical composition of diets		
Dry matter (%)	53.31	56.29
Crude protein (CP, %)	16.50	17.40
Crude fiber (%)	35.20	38.67
Acid detergent fiber (ADF, %)	21.42	21.40
Neutral detergent fiber (NDF, %)	29.59	33.40
Net energy for lactation (NE _L , Mcal kg ⁻¹) ²⁾	1.52	1.51

¹⁾ Premix contained (kg⁻¹): Cu 2 142 mg; Mn 15 428 mg; Zn 15 428 mg kg⁻¹; Co 28 mg; I 231 mg; Se 57 mg; vitamin A 2 285 000 IU; vitamin D 457 000 IU; vitamin E 11 400 mg.

²⁾ NE_L was estimated according to NRC (2001).

³⁾ MF ration=ratio with mixed forage.

⁴⁾ CS ration=ratio with corn stover as unique forage. –, feedstuffs were not included in the ration.

cows had unlimited access to fresh water.

2.2. Data collection

The amount of feed offered was recorded daily and refusals were collected and weighed every two days for individual cows. Sample of diets and refusals were collected twice a week for dry matter (DM), crude protein (CP), acid detergent fiber (ADF) and neutral detergent fiber (NDF) analysis. Daily DMI for individual cows was calculated by subtracting theorts from the feed offered.

Individual cow's body weight (BW) was measured weekly and cows were milked twice daily at 0700 and 1900 h using a robotic sampling system (Rotary milking parlors, Afimilk, Israel). Milk yield and days in milk were recorded. Milk composition was determined twice per week by mixing samples of morning and afternoon milk in a ratio of 3:2 by volume.

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