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Livestock Production Science 92 (2005) 233–240

LIVESTOCK PRODUCTION SCIENCE

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The prediction of the intake potential of grass silage in the supplemented diets of lactating dairy cows

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Received 14 December 2000; received in revised form 19 July 2004; accepted 23 August 2004

Abstract

This study was undertaken to develop models which could be used in conjunction with the near infrared reflectance spectroscopy (NIRS) analysis of grass silage to accurately predict the intake potential of grass silage when offered to lactating dairy cows as part of a mixed diet. Empirical models were developed with data collected from two large-scale studies carried out at the Institute. The models comprised of (1) a linear equation for converting the NIRS-based predicted intake of a given silage for beef cattle to dairy cows and (2) a model which corrected the intake potential of the grass silage for supplementary concentrates. Furthermore, a milk yield adjustment factor of 0.14 kg DM/kg milk was utilised to standardise milk yields. Both linear and exponential models were developed to describe the decrease in silage intake as concentrate intake increased, with *y*-axis intercepts corresponding to unsupplemented silage intakes (NIRS-based predictions for beef cattle adjusted for dairy cows) and common *x*-axis intercept of 168.0 (SE=20.50) and 203.8 (SE=5.64) g/kg $W^{0.75}$, respectively, corresponding to concentrate intake when offered as a sole feed. A common *r* parameter (model curvature) of 1.0047 (SE=0.00397) was assumed for the exponential model. When the models were validated against the data from an independent study, the predictions from the two models were not significantly different, giving R^2 values of 0.70. The intercept and slope from the linear model were 5.39 and 1.01, respectively, and the intercept and slope from the exponential model were 6.10 and 0.98, respectively. Both intercepts and slopes were not significantly different from 0 and 1, respectively. Ninety-three percent of predictions were within 10% of observed intakes in the validation data.

Keywords: Dairy cattle-feeding and nutrition; Predicted grass silage ad libitum intake; Concentrate supplementation; Empirical model; Substitution rate

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doi:10.1016/j.livprodsci.2004.08.015

1. Introduction

Research at the Agricultural Research Institute of Northern Ireland has shown that laboratory-based silage characterisation methods based on near infrared reflectance spectroscopy (NIRS) can substantially improve the accuracy of prediction of silage intake when grass silage is offered as the sole feed to beef cattle (Steen et al., 1998). However, a major proportion of silage is offered to dairy cows, and for nutritional programs, there is a need to develop models which will apply the predictions based on beef cattle into a practical dairy cow context—where silage dry matter intake (SDMI) depends on the silage, the cow and the proportion of other feed in the diet. Silage quality varies greatly in terms of its chemical and biological composition, and this, in turn, results in major variations in ad libitum silage intake in dairy cows. Further to this variation, in practical dairy systems, forages are often supplemented with different types and levels of concentrates which have the effect of increasing total dry matter intake but decreasing forage dry matter intake. It is therefore important that the effect of the level of concentrate supplementation is incorporated into any silage intake prediction model for dairy cows. Finally, the level of production by the dairy cow has also been recognised as an important factor influencing voluntary intake and should be included into the model as a correction factor.

Previously published models have recognised the importance of the inclusion of concentrate supplementation (Lewis, 1981; Vadiveloo and Holmes, 1979; Oldham et al., 1998) and milk yield (Lewis, 1981; Fox et al., 1992) as factors influencing voluntary intake, while some have placed further importance on other animal factors, such as stage of lactation (Vadiveloo and Holmes, 1979; Fox et al., 1992) and milk composition (Fox et al., 1992). The objective of the present study was to develop empirical models for dairy cattle as an extension to the NIRS-based prediction of the intake of grass silage offered as a sole feed to beef cattle (Steen et al., 1995). The development included (1) conversion of the NIRS-predicted intake of grass silage in beef cattle to a predicted intake when offered as the sole feed to dairy cows of a given milk yield; (2) correction of the grass silage intake potential to allow for concentrate supplementation; and (3) an adjustment of the grass silage intake potential to allow for variable milk yields.

2. Material and methods

2.1. Relationship between silage intake in beef and dairy animals

The data used to develop this mathematical relationship were derived from the study by Agnew et al. (2001) (in which 136 silages were offered simultaneously and unsupplemented to beef cattle and dairy cows). The silages were selected from 136 silages produced on commercial farms in Northern Ireland, where a range of silage additive treatments and ensiling techniques were used. They were selected on the basis of their pH, dry matter, ammonia and ME concentrations with the aim of obtaining a wide range of chemical compositions. The vast majority of silages were made from perennial ryegrass dominant swards with low or zero concentration of clover. Of the silages selected, dry matter ranged from 155 to 423 g/kg, pH ranged from 3.50 to 5.49 and in vivo dry matter digestibility (DMD) ranged from 0.53 to 0.80.

2.2. Relationship between silage intake and concentrate supplementation in dairy cows

The data used to develop this model were derived from a study carried out at the Agricultural Research Institute of Northern Ireland (Mayne et al., 1995). In this study, eight silage types were offered to 128 late lactation cows (106−244 days in milk, milk yield=11.9±5.2 kg/day) in a four-period changeover design experiment, with silage intake recorded over the last 5 days of a 14-day period. A total of 19 supplement treatments were examined with each silage type, investigating the effect of concentrate level (unsupplemented, 3.5, 6.8 or 9.8 kg DM/day), protein concentration (g/kg DM; low [135], medium [215] and high [294]) and energy source (a high level of either starch or fibre). The eight silage types differed in their fermentation characteristics, dry matter content and digestibility. Dry matter concentration ranged from 162 to 359 g/kg, digestible organic matter in the DM ranged from 666 to 775,