NebGuide

Nebraska Extension

Research-Based Information That You Can Use

G2316 · Index: Animal Agriculture/Dairy
Issued March 2021

MUNCH

A Smartphone Application for Effective Fiber for Dairy Cows

D. Logan Morris, Animal Science Research Project Coordinator

Kimberly Clark, Dairy Systems Extension Educator

Paul J. Kononoff, Dairy Extension Specialist, University of Nebraska–Lincoln

Robin R. White, Assistant Professor, Animal Science and Poultry, Virginia Tech

Mary Beth Hall, Animal Scientist, U.S. Dairy Forage Research Center

Jeffrey L. Firkins, Professor, Animal Sciences, The Ohio State University

Providing adequate effective fiber to lactating cows is essential to maintain rumen health and function. MUNCH, a free mobile phone app, can help dairy producers determine adequate fiber.

Introduction

Dairy cows must consume adequate amounts of effective fiber. Effective fiber are long fibrous particles that are important constituents of the rumen mat formation, which retains smaller feed particles and promotes rumen digestion. Effective fiber is important in maintaining rumen pH because it stimulates rumination and salivary buffer production. The particle size of fiber consumed by a dairy cow is known to affect feed intake, chewing activities, rumen fermentation, and milk fat production. Several systems have been developed to quantify the "effectiveness of fiber." Feeding recommendations for carbohydrates from the National Research Council (2001, Table 4–3, Page 37) provide recommended minimum forage NDF (fNDF), NDF, and ADF and maximum non-fiber carbohydrates dietary content. Although this table has proven to be useful, it does not account for the effect on the rumen environment of other factors such as dietary starch, dry matter intake, or particle size of a TMR. Recently, a new effective fiber system that includes the effect of dietary factors on particle size recommendations was developed and published in a mobile phone application called MUNCH (https://dairy.unl.edu/munch-effective-fiber-app; see the section Further Detailed Information on MUNCH for more detailed information). The program uses TMR particle size measures of the Penn State Particle Separator (Kononoff et al., 2003).

MUNCH is available free of charge on Google Play and App Store.

MUNCH, an effective fiber calculator for dairy cows

A flow chart for a step-by-step process to use MUNCH to supply adequate fiber is illustrated in *Figure 1*. Prior to using MUNCH, determine dietary inputs using commercial feed analysis or a computer software program.

Steps to using MUNCH.

1. Check desired rumen conditions and set "Min TMR Particle Size." To do so select "Advanced Settings" – Default is Target. Changing to "- Target (↓paNDF)" or "- - Target (↓paNDF)" will reduce effective fiber and decrease 0.315- inch sieve (second sieve) recommendations. Making these dietary changes should be based

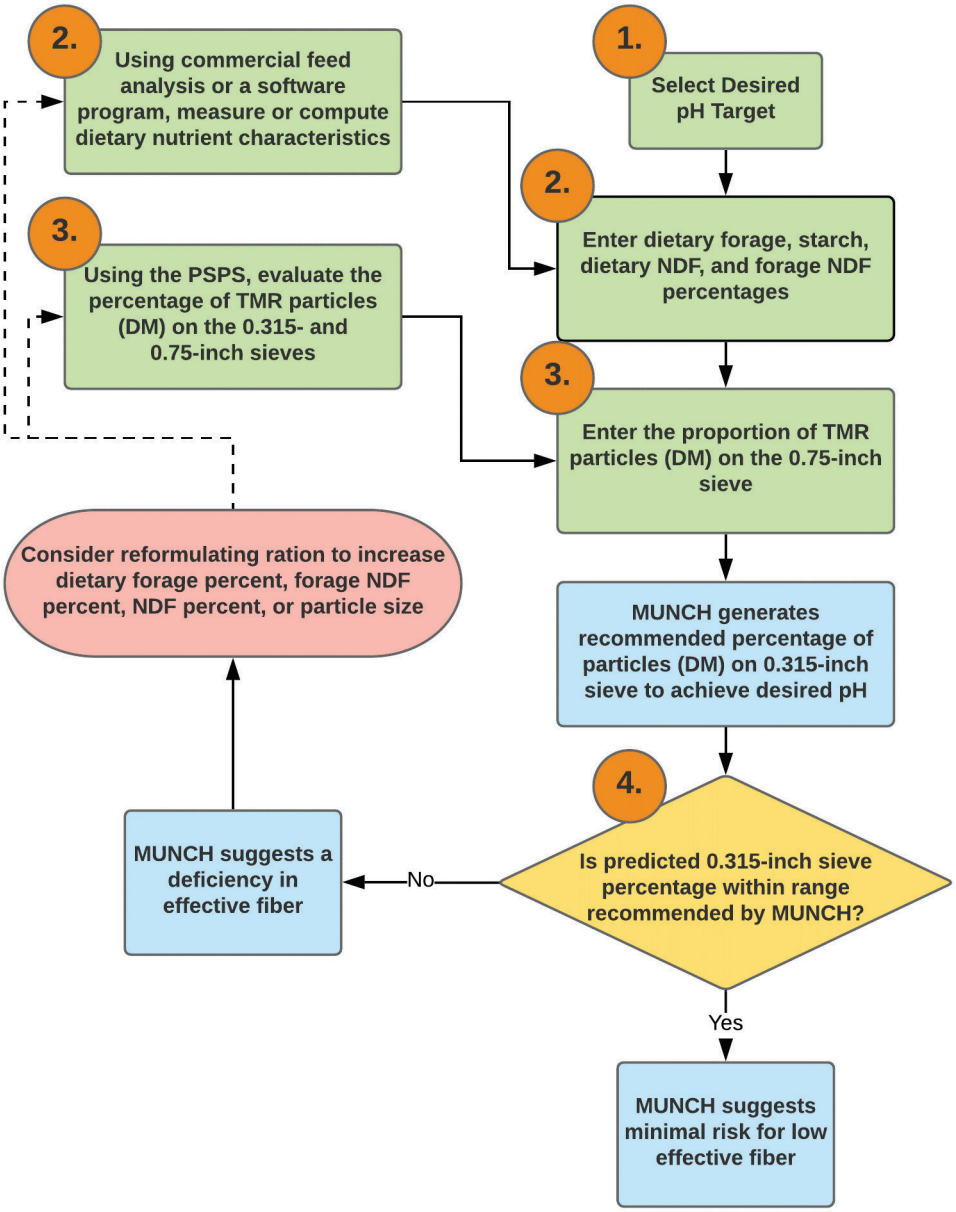

Figure 1. Steps to use MUNCH to supply adequate effective fiber to lactating dairy cows.

on personal observations and informed professional opinion and may increase risk of unfavorable rumen conditions. Enter dietary percentages of forage, starch, NDF, and forage NDF.

2. Mix the diet and using a Penn State Particle Separator determine particle size on a DM basis. Enter the proportion of TMR particles retained on the 0.75-inch sieve (DM basis).

3. Compare the MUNCH recommended 0.315-inch sieve percentage with that of the actual 0.315-inch sieve—Is the actual 0.315-inch percentage within the range recommended by MUNCH? If yes, the system suggests a minimal risk for low effective fiber. If no, the system suggests a deficiency in effective fiber; consider reformulating the diet. See the section "Effect of Dietary Manipulation on 0.315-inch recommendations" for recommended changes and repeating the evaluation process.

Example diet in MUNCH. An example diet is illustrated in *Figure 2.* After putting all inputs into MUNCH, the recommended amount of the TMR on the 0.315-inch sieve is 43.2 ± 10% (DM basis). It is extremely important to note that the recommended value is not an absolute number but rather the mean of the range of recommendations indicated by the ± value. For this example, a 0.315-inch sieve value between 33 and 53% is reasonable. Values on the lower end are more likely to be deficient in effective fiber, whereas values on the upper end might limit intake. Additionally, MUNCH predicts minutes of rumination, which is calculated under the assumption that actual percentage of feed particles on the 0.315-inch sieve is equal to the recommendation. This value is primarily for descriptive purposes; low rumination time suggests an increased risk for effective fiber deficiency.

Effect of dietary manipulation on 0.315-inch sieve recommendations

Because of the complex nature of dietary manipulation on the rumen environment and the correlation between dietary variables, the effects of dietary manipulation of particle size recommendations are complex. Even so, by understanding the effect of changes in each input variable on the biology of the cow, one can manipulate dietary characteristics to generate attainable particle size recommendations. The effects of changes in dietary variables on particle size recommendations and predicted time ruminating are outlined in *Table 1.*

0.75-inch ("top") sieve. Increasing 0.75-inch sieve

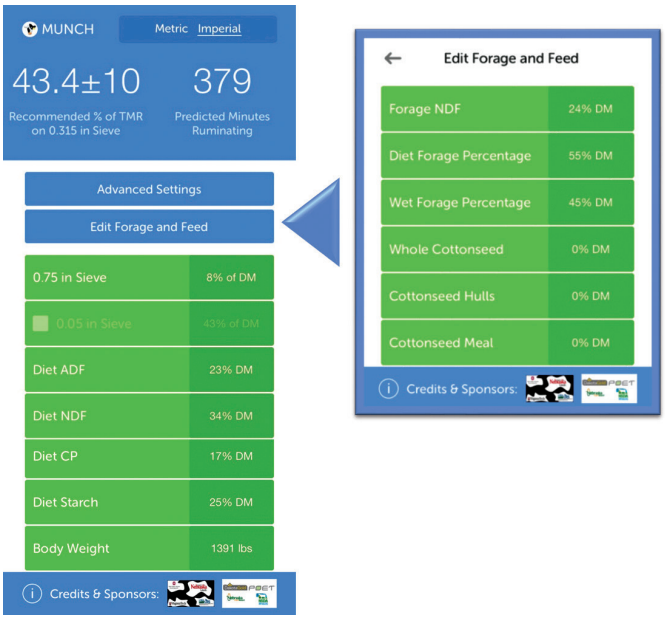

Figure 2. An example recommendation from MUNCH for the % of TMR (DM basis) on the 0.315-inch sieve to achieve the programs TMR particle size "Target" for a diet containing (DM basis) 8% 0.75-inch particles, 23% ADF, 34% NDF, 17% CP, 25% starch, 24% forage NDF, 55% forage, 45% of TMR as wet forage, and 0% cottonseed, assuming a body weight of 1,391 lb.

Table 1. Using the example diet above, effect of changes in MUNCH input variables on recommended % of DM on 0.315-inch sieve of a Penn State Particle Separator and predicted minutes ruminating.

Input	Change	0.315-inch sieve recommendation	Minutes ruminating
0.75-inch ("top") sieve	8% to 12%	43.2±10 to 39.6±9%	346 to 351
Diet NDF	Diet NDF: 34 to 35% Starch: 25 to 24%	43.2±10 to 42.7±10%	346 to 339
Starch	Diet NDF: 34 to 33% Starch: 25 to 26%	43.2±10 to 47.2±9%	346 to 352
Forage NDF	24 to 26%	43.2±10 to 33.2±8%	346 to 307
Forage percentage	55 to 60%	43.2±10 to 49.0±11%	346 to 345
Wet forage	45 to 50%	43.2±10 to 42.6±10%	346 to 339
Whole cottonseed	0 to 5%	43.2±10 to 43.3±10%	346 to 354
Body weight	1,391 to 1,350 lb.	43.2±10 to 40.1±9%	346 to 350
Crude protein	17 to 17.5%	43.2±10 to 51.4±12%	346 to 376
Advanced settings	- Target (↓paNDF)	43.2±10 to 21.8±5%	346 to 256
Advanced settings	- - Target (↓paNDF)	43.2±10 to 8.8±2%	346 to 204

measurements will increase rumination time, which will increase rumen pH or decrease 0.315-inch sieve recommendations. Increasing 0.75-inch particles can be achieved by increasing the chop length of straw or hay. However, excess long particles (>15% DM basis) concentration of the TMR on the 0.75-inch sieve) can decrease dry matter intake and/or increase TMR sorting, and MUNCH does not account for these effects.

NDF. In general, increasing NDF will increase rumination time that via an increase in rumen buffer potential will decrease 0.315-inch sieve recommendations. Although NDF per se is not directly correlated with rumination time, it is positively associated with forage NDF inclusion and 0.75-inch sieve measurements, both of which stimulate rumination. Also, when more NDF is included in the diet, something has to be replaced, which is often starch.

Starch. Increasing starch will via an increase in acidotic load in the rumen increase 0.315-inch particle size recommendations. As described for NDF, dietary starch is negatively correlated with dietary NDF.

Forage NDF. Increasing forage NDF will increase rumen pH or decrease 0.315-inch sieve recommendations. This occurs because forage NDF will stimulate rumination and chewing activity and is typically digested at a slower rate than non-forage NDF

Forage percentage. The effect of changes in forage inclusion on particle size recommendations is difficult to interpret because it is highly dependent on the source of forage that is changed and what concentrate ingredients are concurrently manipulated. However, forage inclusion has a strong positive correlation with 0.315-inch particle size. Therefore, if diets are deficient in 0.315-inch particles and forages are appropriately processed, increasing forage inclusion will increase the supply of 0.315-inch particles.

Wet forage and cottonseed. The effects of wet forage or cottonseed inclusion on 0.315-inch particle size recommendations are small.

Body weight and crude protein. Body weight and dietary crude protein can have a large influence on particle size computations. However, these changes are not biologically based, but are primarily a function of the data used in model development. The data used was collected almost exclusively from Holstein cows that were approximately 1,400 lb and were consuming diets with around 17% crude protein. Therefore, using the body weight of a Jersey cow is likely to result in erroneous recommendations for % of TMR on a 0.315-inch sieve. For example, changing body weight from 1,391 lb to 1,000 lb results in a 0.315-inch sieve recommendation of 17.8% (DM basis). Feeding a diet with this particle size is likely to result in acidosis. Changes in dietary crude protein will result in similar recommendations. **Therefore, we recommend only minor changes in body weight (1,300 to 1,500 lb.) and dietary crude**

protein content (16.8 to 19.0%) even if actual parameter values fall outside these ranges.

Target (↓paNDF) or – Target (↓↓paNDF). If the user feels that the target proportion of particles is high and based on professional judgment, effective fiber can be reduced the user can choosing the "Advances Settings" button and then choose "Min TMR Particle Size" button. From here the user can reduce the target by one-step or two steps by selecting either - Target (↓paNDF) or - - Target (↓↓paNDF). When doing do the user is reducing the rumen pH target by 0.05 at each step.

Further Detailed Information on MUNCH

The aim of a recent meta-analysis by White et al. (2017a) was to quantify the effect of physical and chemical characteristics of dairy cow diets on rumen pH. Because rumen pH is an indicator of normal rumen function it can serve as a proxy for the effective fiber. However, rumen pH is affected by a number of factors. Specifically, rumen pH decreases with increased dietary inclusion of starch and increased dry matter intake, whereas rumen pH typically increases with increased particle size, increased dietary content of forage NDF, and replacement of dietary starch with nonforage NDF.

From the work of White et al. (2017a), a new physically adjusted neutral detergent fiber (paNDF) system was created that has recently been implemented in the MUNCH smartphone app. This application uses a modeling approach from White et al. (2017b). Models from a range of dietary scenarios, such as high-or low-starch diets, are identified and used to predict the amount of the TMR that should be on the 0.315-inch sieve (DM basis), commonly known as the "second screen" of a Penn State Particle Separator, to maintain a user-defined rumen pH. Additionally, a confidence range for 0.315-inch sieve recommendations is produced from the minimum and maximum predictions of the model. MUNCH allows users to input dietary characteristics, and the application will generate recommendations for the amount of the TMR that should be on the 0.315-inch sieve (DM basis) of a Penn State Particle Separator for lactating dairy cows.

Particle size inputs for MUNCH should be on a dry matter basis. This is because these measures were most useful in the statistical solutions for effective fiber. We recognize that it isn't always practical to determine particle size measures on a dry matter basis. When using particle size measures on an as-fed basis users may be interested in knowing that based upon our data the proportion of DM retained on the 0.75-inch "top screen" averaged over 1% less and almost 2% less on the 0.315-inch "second screen" than portions of as-fed material. Additionally, the proportion of DM retained on the bottom pan (< 0.315-inches) averaged almost 3 % greater than portions of as-fed material.

Summary

Providing adequate effective fiber to lactating cows is essential to maintain rumen health and function. Recently, models have been developed to determine the effective fiber requirements of lactating cows, measured as particle size, when accounting for dietary composition. These models have been converted into a mobile phone application, MUNCH. This NebGuide outlines how MUNCH can be used as an aid to provide adequate effective fiber to dairy cows and how manipulation of dietary composition affects MUNCH's recommendations for % of TMR on the 0.315-inch sieve of a Penn State Particle Separator.

Resources

NRC. 2001. Nutrient Requirements of Dairy Cattle. 7th rev. ed. Natl. Acad. Sci., Washington, DC.

Kononoff, P.J., A.J. Heinrichs, and D.R. Buckmaster. 2003. Modification of the Penn State forage and total mixed ration particle separator and the effects of moisture content on its measurements. Journal of Dairy Science 86:1858–1863.

White, R. R., M. B. Hall, J. L. Firkins, and P. J. Kononoff. 2017a. Physically adjusted neutral detergent fiber system for lactating dairy cow rations. I: Deriving equations that identify factors that influence effectiveness of fiber. J. Dairy Sci. 100:9551–9568. doi:10.3168/jds.2017–12765. LINK to Open Access Article: https://www.journalofdairyscience.org/article/S0022–0302(17)30894–9/fulltext

White, R. R., M. B. Hall, J. L. Firkins, and P. J. Kononoff. 2017b. Physically adjusted neutral detergent fiber system for lactating dairy cow rations. II: Development of feeding recommendations. J. Dairy Sci. 100:9569–9584. doi:10.3168/jds.2017–12766.

LINK to Open Access Article: https://www.journalofdairyscience.org/article/S0022–0302(17)30895–0/fulltext

This publication has been peer reviewed.
Nebraska Extension publications are available online at http://extensionpubs.unl.edu/.