Farmer summary: Description and effect of functional fibre in forages on rumen function, performance and health of UK dairy cows

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Farmer summary

Background

To sustain the increase in milk production that has been witnessed in the UK over the last 25 years has required an increase in the level of concentrate supplementation and the production of high quality forages, with a trend towards lower dietary fibre levels. In addition, a short forage chop length is often desired by farmers and contractors to improve compaction in the clamp and reduce aerobic spoilage at feed out.

The particle size (PS) of the diet has been proposed as a key factor, along with its fibre (measured as neutral detergent fibre; NDF) and non-forage carbohydrate concentration to ensure a healthy rumen function and maintain animal performance. Adequate forage particle size (PS) is necessary to stimulate chewing activity and as a consequence saliva production, which is required to neutralise acid production in the rumen and maintain a ruminal pH above pH 5.8 Adequate forage particle size is also necessary to produce a fibre mat in the rumen which retains smaller forage and feed particles, thus increasing their digestion.

When forage PS and peNDF (physically effective fibre) are too low, they adversely affect rumination, decrease ruminal pH and the level and activity of cellulolytic bacteria in the rumen. As a consequence, there is an increased risk of subacute ruminal acidosis (SARA), and milk fat depression. Field studies in the USA indicate that 19% of early lactation and 26% of mid-lactation dairy cows suffer from SARA.

In contrast, when PS and peNDF are too high, feed intake is reduced due to greater rumen fill. Additionally, too long a forage particle size promotes sorting in the feed passage, resulting in some cows receiving excess concentrates and others insufficient. The effects of PS and peNDF in dairy cow studies are also complicated by the level of inclusion and rate of degradability of supplementary concentrates.

Accurate assessment of forage PS in dairy cow diets is difficult, and current feeding tables and nutritional programs do not include this parameter, despite its importance. There are several methods available to assess PS and peNDF in the diet although there is no accepted standard, and all have been developed for comparatively dry North American style diets based on lucerne haylage and maize silage. As a consequence, the methods currently available to assess PS and peNDF may not be suitable for the wetter grass and maize silages commonly fed in the UK.

Study 1. Particle size and physically effective fibre distribution in a range of grass and maize silages, and the efficacy of mixing and extent of diet selection of total and partial mixed rations on UK dairy farms

The objective of this study was to determine the PS distribution of grass and maize silages and total/partial mixed rations on UK dairy farms, and to evaluate the consistency of ration mixing and extent of diet selection.Particle size distribution of mixed rations (MR), grass silage (GS) and maize silage (MS) was investigated on 50 farms throughout GB. The study used a modified Penn State Particle Separator (PSPS) with additional sieves (27, 44 and 60 mm) to better describe wetter UK diets and grass silage.

Key findings

The particle size distribution of the GS and GS-based MR being fed on UK dairy farms are considerably different from North American diets. There is a higher percentage of long particles (retained on the top sieves) and a low percentage of fine particles (retained on the bottom sieves). The PS distribution of maize silage is closer to North American recommendations.

About 58% of the sampled farms had poorly or moderately mixed rations This results in a different diet being available along the feed face, which could affect the performance and/or health of individual cows. There is also significant diet selection on many (66%) of farms with cows selecting for shorter material on some farms and longer material on others. This could also affect individual cow performance and/or health. About 34% of the farms had no feed refusals in the morning, indicating underfeeding.
There is little evidence of an effect of mixer wagon type on particle size distribution, but there is considerable variation between farms in mixing protocol

Take home messages

- It is important to feed a diet with the correct particle size distribution: too long a particle length can reduce milk yield and increase diet selection, whereas too short a particle length can reduce milk fat content and possibly lead to sub-acute acidosis.
- To adequately characterise the particle distribution of UK diets requires the use of a modified Penn State Particle Separator, with an additional 33 and 44 mm sieves for grass silage or grass silage based diets
- The chop length of UK grass silage is considerably longer than North American recommendations. Maize silage chop length is similar to North America.
- Monitoring ration mixing consistency and degree of sorting is key to promptly detect and correct any mistakes. A well formulated diet can result in poor cow performance and higher risk of SARA if it is not well mixed or if it can be easily sorted.
- Make sure to have a certain amount of feed refusals (around 3-5% of the mixed ration fed) to avoid underfeeding and ensure that these refusals have a composition similar to the ration originally fed out.

Study 2. Effect of grass silage particle size when fed alone or with maize silage on the performance, rumen pH and metabolism of Holstein-Friesian dairy cows

The objectives of the study were to evaluate the effect of chop length of grass silage when fed alone or in combination with maize silage on dairy cow performance, reticulo-rumen pH, milk quality, diet digestibility, metabolism and feeding behaviour.

Sixteen multiparous Holstein-Friesian cows were used in a 4×4 Latin square design with four periods each of 28-days duration. Perennial ryegrass was harvested at two chop lengths: short (within the shortest 5% of grass silages surveyed in the UK at 30.9 mm), or long (approximately the mean length of grass silage in the UK at 44.2 mm). Grass silage was then included at two ratios of grass to maize silage (MS) of 100:0 or 40:60 (DM basis). The four treatments were therefore long grass silage (LG), short grass silage (SG), long grass silage with maize silage (LM) or short grass silage with maize silage (SM). Rumen pH was determined using pH boluses administered to each cow.

Key findings

- DM intake is higher with a short chop length grass silage (+ 1 kg/day) and with the inclusion of maize silage
- A shorter chop length increases milk yield (+2 kg/d) in grass silage based diets, but decreases milk fat content (by 2g/kg), with milk fat yield being unaffected
- There is no effect of grass silage chop length on ruminal pH, but the inclusion of maize silage reduces pH, although values (pH<5.8 for 5 to 6 h/d) are well above that associated with sub-acute ruminal acidosis (SARA)
- The inclusion of maize silage in the ration increases milk yield and liveweight gain

Take home messages

- In diets properly formulated, mixed and fed out, a short cut grass silage does not not on its own increase the risk of SARA. Cows fed short cut grass silage will eat more dry matter and produce more milk; milk fat content (but not yield) may however be lower
- Feeding a mixture of grass and maize silage increases intake, milk production, milk protein content and live weight gain in comparison with grass silage alone.
- Inclusion of maize silage does not increase the risk of SARA regardless of the grass silage chop length

Study 3. Effects of fibre to starch ratio in diets differing in grass to maize silage ratio on performance, rumen function, nitrogen balance and acute phase proteins in dairy cows

The objective of this study was to determine the effect of different concentrate starch levels when fed at different ratios of a short chop grass silage to maize silage on rumen pH, digestibility, rumen function and passage kinetics, eating behaviour, immune response, and performance in dairy cows.

Four rumen fistulated high yielding dairy cows in early lactation were randomly assigned to one of 4 dietary treatments within a 4 × 4 Latin Square Design, for 4 periods each of 28-d duration. The first cut grass silage used was within the shortest 1% being fed in the UK at 23.6 mm, whilst the maize silage had an average particle size at 10.2 mm. The four dietary treatments were

- **GF**: high grass silage (82:18 G:M), high fibre (400 g NDF/kg DM)/low starch (120 g/kg DM)
- **GS**: high grass silage (82:18 G:M), high starch (240 g /kg DM) and 295 g NDF/kg DM
- **MF**: high maize silage (18:82 G:M), high fibre (350 g NDF/kg DM) and 215 g starch/kg DM
- **MS**: high maize silage (18:82 G:M), high starch (320 g/kg DM) and 270 g NDF/kg DM

Key findings

Feeding high starch diets (GS and MS)

- tended to reduce the time cows spent ruminating, but had no effect on rumen pH
- Had no effect on DM intake, milk yield or milk protein content, but decreased fibre digestion and increased milk fat content
- Elevated indicators of inflammation (haptoglobin), although this remained within the normal range

Feeding a diet high in high maize silage (MF and MS)

- Increased DM intake, milk yield and milk protein content, but decreased milk fat content.
- Tended to decrease rumen pH, and decreased the ruminal acetate:propionate ratio
- Improved the efficiency of conversion of dietary nitrogen to milk nitrogen

Take home messages

- Under UK conditions, feeding high levels of maize silage with short chop length grass silage and high dietary starch can be achieved without a negative impact on rumen pH, intake or milk performance if the diet is appropriately formulated, mixed and fed so that there is no diet selection, and the starch source is not rapidly degraded in the rumen.

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