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Feed sorting in dairy cattle: Causes, consequences, and management[1]

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ABSTRACT

Dairy cattle commonly sort total mixed rations, a behavior that influences individual nutrient intake and reduces the nutritive value of the ration left in the bunk across the day. Typical patterns of feed sorting in lactating dairy cows, against longer forage particles, result in greater intake of highly-fermentable carbohydrates and lesser intake of effective fiber than intended, and are associated with reduced rumen pH and altered milk composition. To understand the reason for this behavior and reduce it on-farm, numerous studies have explored the influences of ration characteristics, feeding strategies, and management factors on the expression of feed sorting. In mature cows and young calves, feed sorting is influenced by forage inclusion rate, particle size, and dry matter content. Feeding strategies that increase the time available to manipulate feed—including decreased feeding frequency and increased feeding level—may result in increased feed sorting. The extent of feed sorting is also influenced by a variety of herd-level factors, but variability between individuals in the extent of feed sorting suggests that this behavior may be subject to additional factors, including previous experience and internal state. The development of feed sorting in young calves has been explored in several recent studies, suggesting that early opportunities to sort feed, as provided by access to mixed diets, may encourage the early onset of this behavior and help it persist beyond weaning. Evidence also supports the role of feedback mechanisms that influence this behavior at the individual level. In calves and adult cows, selective consumption of higher-energy ration components may be linked to energy demands, as influenced by the availability of supplemental feed or changing metabolic status. Further, considerable evidence suggests that cattle will adjust patterns of feed sorting in favor of physically effective fiber to attenuate low rumen pH, providing evidence for the role of postingestive feedback in feed sorting. In general, as long as cattle are provided with mixed diets that satisfy the average nutrient requirements of the group, feed sorting needs to be reduced, either through direct management or by discouraging the early development of the behavior. However, feed sorting may be functional in some scenarios, and continued research is needed to understand the feedback mechanisms that influence feed selection and sorting in young calves, replacement heifers, and mature cows.
Key words: feed sorting, feeding behavior, dairy cow, dairy calf

INTRODUCTION

It is common in the dairy industry for lactating dairy cows to be provided a TMR, with the aim of providing the balanced nutrients needed to maintain a stable and efficient microbial population (Coppock, 1977). However, the propensity of dairy cows to select (sort) within their ration and alter their nutrient intake remains an ongoing practical challenge on-farm. Ruminants are capable of selectively consuming certain portions of plants (Methu et al., 2001), and this ability extends to the consumption of a TMR. Sorting behavior, typically against longer forage particles and in favor of smaller particles, has been reported numerous times (Leonardi and Armentano, 2003; Leonardi et al., 2005a; Miller-Cushon and DeVries, 2009); it results in an unbalanced intake of nutrients and reduces the nutritive value of the ration found in the bunk across the day (DeVries et al., 2005). Feed sorting is typically addressed by attempting to thwart sorting at the herd level, through nutrition and feeding management. However, dairy cattle vary in both the degree and pattern of feed sorting (Leonardi and Armentano, 2003), and research over the past several years has also addressed factors that may influence feed sorting at the individual level, including previous experience (Miller-Cushon et al., 2013a) and rumen health (DeVries et al., 2008). Despite an abundance of literature that addresses feed sorting from several different angles, to our knowledge

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no attempt has been made to summarize the available research on this topic. In this review, we first outline the significance of feed sorting for production and health outcomes. Second, we discuss the influence of common feeding and management factors on feed sorting in calves, heifers, and cows. Third, we summarize the current state of knowledge regarding the development of feed sorting behavior in young calves. Last, we describe evidence for internal factors that may drive or provide feedback for dietary selection patterns.

IMPLICATIONS FOR HEALTH AND PRODUCTION

Feed sorting may be problematic if it leads to consumption of a diet that is different from what was formulated and delivered. Mature dairy cows have been shown to sort for the smaller feed components of their TMR, discriminating against longer forage components (Leonardi and Armentano, 2003; DeVries et al., 2007). Sorting of a TMR can mean that the ration cows actually consume is much higher in fermentable carbohydrates than intended, and much lower in effective fiber. This, in turn, may increase the risk of depressed rumen pH and SARA. In support of that hypothesis, DeVries et al. (2008) demonstrated associations between sorting and various measures of rumen pH. For example, they noted an association between sorting of long ration particles [i.e., particles >19 mm screen of the Penn State Particle Separator (**PSPS**); Kononoff et al., 2003] and maximum rumen pH ($R^2 = 0.46$): those cows selecting most against long particles had the lowest maximum rumen pH (DeVries et al., 2008). The same authors also reported that increased sorting for particle fractions that were higher in starch and lower in NDF was associated with reduced ruminal pH variables (DeVries et al., 2008). More recently, Gao and Oba (2014) demonstrated similar associations: cows that were tolerant of a high-grain diet sorted their diet to a lesser degree than cows susceptible to the high-grain diet. Susceptible cows experienced more severe SARA and sorted their diet against long particles. This pattern of sorting has been associated with lower milk fat percentage in 2 studies (DeVries et al., 2011; Fish and DeVries, 2012), likely as a result of imbalances in intake of highly fermentable carbohydrates and effective fiber, leading to SARA. In both studies, milk fat decreased by 0.15 percentage points for every 10% refusal of long forage particles in the ration. More recently, Miller-Cushon and DeVries (2015) found a similar association, with milk fat increasing by 0.1 percentage points for every 10% selection in favor of long ration particles.

Imbalanced nutrient intake and altered rumen fermentation as a result of sorting, can affect digestion efficiency and production. In support of this, a cross-section study of commercial herds feeding TMR found that efficiency of milk production (calculated as milk yield divided by average DMI) decreased by 3% for every 1 percentage point of group-level selective overconsumption (sorting) of fine ration particles [particles <1.18 screen of the PSPS; Sova et al. (2013)]. Sorting of a TMR can also reduce the nutritive value of what remains in the feed bunk, particularly in the later hours after feed delivery (DeVries et al., 2005; Hosseinkhani et al., 2008). For group-fed cattle, this may have a negative effect on cows that do not have access to feed when it is delivered. For example, high competition at the feed bunk may restrict subordinate, primiparous, or compromised (e.g., lame) animals to feeding later in the day, and these cattle may end up consuming a ration that is different from that formulated for their production and growth requirements. This, in turn, may affect production targets; for example, diets that are higher in NDF and lower in energy can restrict DMI and reduce milk yield (Rabelo et al., 2003). Sova et al. (2013) demonstrated that every group-level increase of 2 percentage points in selection against long ration particles was associated with a per-cow reduction of 0.9 kg/d of 4% FCM. Imbalances in nutrient intake relative to that predicted may also limit cows' ability to optimize milk components; for example, Miller-Cushon and DeVries (2015) reported that milk protein content decreased by 0.05% for every 10% refusal of long ration particles.

Feed sorting may also affect the time course of feed consumption. Greter and DeVries (2011) associated greater sorting against long ration particles with a slower rate of feed consumption ($R^2 = 0.57$). It is noteworthy that the same researchers could also explain ~25% of the variability in DMI by cow feed sorting patterns. In particular, reduced DMI was associated with more sorting against long particles ($r^2 = 0.23$) and with more sorting for short ration particles ($r^2 = 0.26$). Thus, in situations where cattle devote much time to sorting their feed, they may also be limiting their ability to maximize their DMI.

It must be noted, however, that these effects of feed sorting are not always consistent. For example, DeVries et al. (2011) demonstrated that, in cows in a period of peak lactation to peak DMI, greater selection against longer ration particles was associated with greater efficiency of milk production. This result could be explained by the fact that across cows, very little sorting of long ration particles (<10% refusal) was observed in that study. Further, given increasing DMI and decreasing milk yield over the study observation period, any refusal of long particles would correspond to less effective fiber intake and could improve feed conversion efficiency (Yang and Beauchemin, 2006a).