Extension
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Silage-specific corn hybrids for dairy cattle diets*

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Maximizing consumption of dry matter or increasing the energy density of the diet are key strategies for improving milk and milk protein yields. Upgrading the nutritional quality of corn silage through hybrid selection may benefit farmers via improvements in lactation performance.

Table 1 summarizes the normal range of corn silage nutrient composition. Starch and fiber (presented as NDF) are the main components and primary sources of energy in corn silage. This article will discuss the pros and cons of silage-specific corn hybrids altering stalk (fiber) and kernel (starch) characteristics of corn plants.

Table 1. Nutrient composition of corn silage[1]

Item	N	Normal range[2]
CP, % DM	606,364	6.7 – 8.7
NDF, % DM	733,421	33.2 – 42.9
NDFD30, % DM	538,535	52.5 – 63.5
uNDF, % DM	510,718	7.7 – 13.2
Starch, % DM	601,430	27.3 – 40.6
StarchD, % of starch	480,408	66.6 – 83.4

[1]Summary of multi-year data set courtesy of Dairyland Labs, Rock River Laboratories and Cumberland Valley Analytical Services.
[2] Normal range represents the range of the central 2/3rds of the samples in the data set.

Stalk characteristics

Silage-specific corn hybrids that alter the stalk portion of corn plants primarily include brown midrib and leafy types. Modifications of stalk characteristics target improvements in fiber digestibility by reducing the concentration of lignin, the indigestible portion of NDF. Brown midrib corn hybrids have reduced lignin concentrations compared with other hybrids, while leafy type hybrids have more leaves above the ear than other hybrids.

Several years ago, we summarized the effects of hybrid types on lactation performance by dairy cows. In addition to brown midrib and leafy hybrids, corn hybrids including an experimental high-fiber digestibility hybrid with a higher NDF but similar lignin concentration, and conventional, dual-purpose, and isogenic counterparts were evaluated.

Table 2 highlights the nutrient composition of these corn hybrids. Minor effects were observed, except for brown midrib hybrids. Brown midrib hybrids had lower starch and lignin concentrations but greater in vitro NDF digestibility than other hybrids. These results thoroughly match multi-year summaries of the University of Wisconsin corn silage hybrid trials which point out consistently greater in vitro NDF digestibility but lower starch concentrations for brown midrib hybrids than the trial average.

Table 2. Nutrient composition of corn hybrids[1,2]

Item	CON	BMR	HFD	LFY	*P*-value
DM, % of as fed	33.9	33.7	34.4	32.6	0.27
CP, % DM	7.8	8.1	8.1	8.0	0.07
NDF, % DM	42.8	43.0	44.7	42.2	0.34
Lignin, % DM	2.9^{a}	2.0^{b}	3.0^{a}	2.6^{a}	0.001
NDFD[3], % NDF	46.7^{b}	58.1^{a}	50.9^{b}	48.5^{b}	0.001
Starch, % DM	29.7^{a}	28.7^{ab}	26.6^{b}	29.9^{a}	0.05

[1]Adapted from Ferraretto and Shaver (2015).
[2]CON – conventional, BMR – brown midrib, HFD - high fiber digestibility, LFY - leafy.
[3]Ruminal in vitro NDF digestibility at 30 or 48 h of incubation.

Achieving greater fiber digestibility of corn silage is desirable for productivity, profitability, and environmental purposes. Low digestibility promotes rumen fill, restricts consumption, reduces milk production, and hinders the establishment of high-forage diets. Forage particles must sink and undergo particle size reduction to leave the rumen. This is accomplished through mastication, chewing and digestion. Corn silage particles of greater fiber digestibility are more fragile and experience greater and faster particle size reduction. The greater flow of particles leaving the rumen opens the door for more feed to be consumed and ensures more energy is available to support milk and milk component production. **Table 3** highlights the effects of feeding brown midrib corn silage on lactation performance by dairy cows. Briefly, total tract NDF digestibility was enhanced, increasing consumption of dry matter and milk yield by 2.0 and 3.3 lb/cow/d, respectively. Milk fat

concentration was slightly lower, but the yield was similar.

Table 3. Effect of feeding brown-midrib corn silage to dairy cows[1,2]

Item	Control[3]	Difference
Dry matter intake, lb/d	53.0	+2.0
Milk yield, lb/d	82.2	+3.3
Milk fat, %	3.63	-0.11
MUN, mg/dL	15.0	-1.0
Total tract NDF digestibility, % of NDF	42.3	+2.5
Total tract starch digestibility, % of starch	92.7	-1.4

[1]Adapted from Ferraretto and Shaver (2015).
[2]Difference calculated as brown-midrib minus control corn silage.
[3]Control included conventional, dual-purpose, and isogenic counterpart corn hybrids.

Table 4 summarizes the studies evaluating brown midrib hybrids conducted after our review study. Briefly, the same response but with greater magnitude was reported for most studies. This is likely due to greater milk production of cows from these more recent trials.

Table 4. Summary of recent studies feeding brown-midrib corn silage to dairy cows[1,2]

Studies	DMI, lb/d	Milk, lb/d	ECM, lb/d	Fat, %
Lim et al., 2015	ND	+4.9	+4.6	ND
Cook et al., 2016	ND	+8.6	+6.4	ND
Hassanat et al., 2017	+3.5	+7.1	+6.4	-0.11
Coons et al., 2019	+2.7	+7.7	+6.9	-0.15
Miller et al., 2020	+1.3	+5.1	+3.1	ND
Miller et al., 2021	+3.3	+6.4	+6.2	-0.07

[1]Results presented as the difference calculated as brown-midrib minus control corn silage.
[2]ND – no difference.

Overall, brown midrib corn hybrids are more digestible and improve lactation performance through increased consumption. However, this comes at the expense of a 10 to 15% yield drag and requires proper inventory planning. For dairies with well-established nutritional groups, perhaps feeding more digestible hybrids to early lactation and high-producing cows and less digestible but high tonnage hybrids to low producing cows could be an option. But this would require managing multiple silos.

Kernel characteristics

Modifying kernel characteristics targeting greater starch availability has potential to increase energy density, improving performance and feed efficiency. The most common modification is adjusting endosperm properties to reduce vitreousness. Vitreousness is the ratio of vitreous to floury endosperm. Floury endosperm is more digestible. However, few feeding trials with corn silage differing in vitreousness are available. And those that are available have hybrids combining floury endosperm with hybrids of varying stalk characteristics (i.e. brown midrib or leafy). These studies often show an increase in starch digestibility with a flourier endosperm type.

Recently, a genetically modified corn hybrid initially developed for ethanol production, Enogen corn, containing a trait that expressed alpha-amylase in the kernel endosperm garnered interest by the dairy industry. The enzyme expressed in the kernel can breakdown starch, thereby increasing the concentration of sugars available during silage fermentation or increasing ruminal and total tract starch digestibility. Feeding this novel hybrid when fermented for shorter periods of time could be an option for dairy farmers unable to increase forage inventories and store silage for longer periods to obtain more digestible starch.

Table 5 summarizes studies feeding Enogen corn silage to dairy cows. Compared with other hybrid types, the number of trials is limited, and one out of the four studies is only available as an abstract which limits the amount of information available and the interpretation of its effects. Thus, caution is advised when assessing these results. Milk production was improved in 2 out 4 studies. But total tract starch digestibility was either not affected or slightly reduced when cows were fed Enogen corn silage.

Table 5. Summary of recent studies feeding Enogen corn silage to dairy cows[1,2]

Item	Cueva et al., 2021	Cueva et al., 2022[3]	Krogstad and Bradford, 2023	Rebelo et al., 2023
DMI, lb/d	ND	ND	ND	+3.4
Milk, lb/d	+4.5	ND	ND	+4.9
ECM, lb/d	ND	ND	ND	ND
Fat, %	ND	NR	ND	ND
FE[4] (lb milk / lb DMI)	+0.2	-0.3	NR	ND
FE[4] (lb ECM / lb DMI)	ND	ND	ND	ND
TTSD[5], % starch intake	ND	NR	ND	-1.0

[1]Results presented as the difference calculated as Enogen minus control corn silage.
[2]ND – not different, NR – not reported.
[3]This study is available as an abstract and information may be preliminary or was not presented.
[4]FE – Feed efficiency.
[5]TTSD – Total-tract starch digestibility.

We (Heinzen et al., 2021) conducted a study in Florida in 2019 to evaluate fermentation and in situ starch disappearance of Enogen corn silage and earlage ensiled for 0, 30, 60, 90 and 120 d. Minor effects of silage fermentation, microbial counts and aerobic stability were observed indicating Enogen corn can be ensiled for longer periods without concerns of undesirable fermentation or greater losses. But Enogen corn had lower in situ starch disappearance. The reason behind this response is uncertain.

Overall, Enogen corn shows some initial promising results. But the mechanism behind improved lactation performance observed in some studies is unclear. Research data on tonnage is not available.

Summary

Growing and feeding silage-specific corn hybrids is an interesting option for dairy operations. However, the pros and cons of each hybrid type, year-to-year variation, and unique challenges for forage production of each farm must be understood and considered. Testing a few fields with novel hybrids is a good initial step. Brainstorming meetings between dairy farmers, nutritionists, agronomists, and crop consultants prior to the implementation of new hybrid types is advised.

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