Dual Purpose Corn Hybrids' (Grain-Silage) Performance Assessment in Northeastern Kansas. II. Quality

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Summary

Dual-purpose corn (*Zea mays L.*) hybrids are capturing the attention of farmers due to their versatility, as their final use can be chosen as either grain or silage. This versatility emphasizes the importance of understanding the yield and quality performance of these hybrids. This study compared eight dual-purpose corn commercial hybrids' quality performance. During the 2023 growing season, a dryland field experiment was conducted in Manhattan, Kansas. We analyzed quality at two crop growth stages: before and after the silage process. Dry matter digestibility (DMD) increased after ensiling, mainly due to starch digestibility of ~85 to ~95%. The 6152D1 hybrid led in terms of crude protein (CP) levels before (9.3%) and after ensilage (8.3%). Hybrid 6235D1 showed the lowest conversion efficiency (i.e., lb/t DM) after the silage process. The waxy hybrid 6219WX showed the lowest value of undigested neutral detergent fiber (uNDFD30t) before ensilage (~20%). Differences between hybrids were found regarding the milk per acre index. The hybrid 6219wx achieved the highest value after the silage process (~14 t/a), whereas the hybrid 6219 was the least productive.

Introduction

Whole-plant corn silage has become a valuable animal nutrition product worldwide. This is due to its capacity for high biomass production, palatability, uniform harvest quality, and seamless ensilaging attributed to its rich soluble sugar content (Karnatam et al. 2023). Historically, commercial corn hybrids were mainly selected by their grain yield (Kim, 2001). However, recently, with the increase in demand for dual-purpose hybrids for use in animal feed, quality variables have become more relevant at the time of genotypic selection. Some of the key quality variables are crude protein (CP), dry matter digestibility (DMD), and digestibility of specific components such as neutral detergent fiber (NFD) and starch. Therefore, the enhancement of these quality variables would lead to an increase in the feed-to-animal product conversion efficiency (i.e., milk per unit of feed consumed).

Located in the Central Great Plains of the United States (US), Kansas stands out for its significant contributions to national agriculture, securing the sixth spot nationwide in corn production and beef cow inventory (USDA, 2022). However, this success brings its own set of challenges, especially in meeting the surging demand from the cattle feeding sector (Kansas Department of Agriculture, 2021). This context emphasizes the importance of evaluating the performance of dual-purpose (grain and silage) corn

hybrids in Kansas for animal nutrition. Therefore, this study aimed to determine the differences in quality variables such as CP, DMD, NDFD, starch, and the undigestible neutral detergent fiber (uNDF30t). This report is the second part of a series, following the initial segment that compared grain yield, grain numerical and physiological components, and the rate of kernel moisture loss among the hybrids. For more information, please read "Dual Purpose Corn Hybrids (Grain-Silage) Performance Assessment in Northeastern Kansas. I. Grain Yield."

Procedures

A field experiment was conducted during 2023 growing season at Kansas State University Experimental Field located in Manhattan, KS, U.S. (39°13'04.5" N; 96°35'55.6 W). The experimental design was a Randomized Complete Block Design (RCBD) with four replicates. Treatments were eight commercial double-purpose hybrids from Beck's company (6278SX, 6241QQ, 6256Q, 6152D1,6219wx, 5963SX, 6219 and 6235D1). The hybrid 6219wx is distinguished by being classified as waxy. The experimental arrangement consisted of eight rows per hybrid in a 20-ft by 65-ft plot. The hybrids were sown on April 17, 2023, with a plant density of approximately 30,000 plants per acre, on silty clay loam soil. The crop remained free from pests and weeds with herbicide application and manual removal. Nutrient availability was not a limiting factor. The experiment was managed without irrigation.

Aboveground biomass samples were collected when corn reached 37% dry matter (DM), being around the R4 corn growth stage, kernel dough (Ritchie et al., 1986). To determine the DM content, two plants per plot were harvested, chopped, and dried using a dryer machine. Once the appropriate dry matter content was obtained, five plants per plot were harvested, cutting at 12 inches of height as common height for silage harvest. Then, those samples were chipped, mixed, and subsequently allocated to two different destinations. For each hybrid, a 200 g sample was sent to the laboratory as the first batch of samples ("before silage") and another 600 g sample was ensiled for 60 days in specialized bags. Once the process of silage was done, the second batch ("after silage") was sent to the laboratory. All the samples were frozen for a week before the quality analysis. The quality variables were measured as wet chemistry analysis in a package called "Core Nutrient Plus Energy" at Rock River Laboratory, Watertown, Wisconsin, (to see the methods go to *https://rockriverlab.com/pages/Guidelines,-Handling,-&-Methods.php*).

A brief interpretation of the variables is described. First, the dry matter digestibility (DMD) represents the digestible portion of feed; consequently, these values are expected to be high. Second, the indigestible neutral detergent fiber (uNDF30t) indicates the fraction that cannot be utilized by animals evaluated with a 30-hour method, and therefore, it is expected that the hybrids will present a low value. Third, crude protein (CP) quantifies the protein concentration in feed, so high CP values are desirable. Last, conversion efficiency is the measure of how effectively livestock convert the feed they consume into useful products.

Statistical analysis

The conversion efficiency and milk yield per acre were calculated using a dairy production estimation model developed by the University of Wisconsin-Madison (MILK2006). This model employs various inputs, including biomass and quality

metrics such as DM, CP, NDFD, starch, and ash. The effect of genotype on the quality variables evaluated was determined by analysis of variance and multiple comparisons among maize hybrids (ANOVA). All the analysis was performed using R software (R Core Team, 2023).

Results

Before silage, the waxy hybrid 6219wx exhibited the highest DMD value at approximately 44%, whereas the hybrid 6235D1 showed the lowest value at around 38% ($P < 0.05$). After the silage process, the DMD increased by ~15% (Figure 1). Furthermore, changes in the DMD were mainly explained by shifts in starch digestibility (from ~85 to ~95%) and in NDFD (Figure 2a; Figure 2b). Moreover, the hybrids 6241Q, 6235D1, and 6219wx presented the lowest values of DMD after silage ($P < 0.05$). Interestingly, the waxy hybrid presented the highest value of DMD before silage, but this result was not observed after silage.

The lowest value of uNDF30t before silage was found for 6219wx (~20%), while the highest value was for 6235D1 (~23%) (Figure 4).

In terms of CP, a decrease of ~9% was found after silage (Figure 3). The hybrid 6152D1 showed the highest value of crude protein before (9.3%) and after silage (8.3%).

The milk production calculated per ton of dry matter consumed was higher before the silage process (Figure 5a). The hybrid 6235D1 was the least efficient in terms of conversion efficiency after the silage process (~2700 lb/t DM) due to its high fraction of uNDF30t. Lastly, Figure 5b shows the milk per acre index, where the hybrid 6219wx achieved the highest value after the silage process (~14 t/a). Conversely, the hybrid 6219 was consistently the least productive in terms of milk yield per acre, both before (10.5 t/a) and after silage (9.5 t/a).

Conclusion

This study showed that quality attributes varied greatly across corn hybrids. While certain hybrids exhibit superior quality before ensiling, they fail to sustain this level of quality after silage. For instance, the hybrid 6219wx showed the lowest value of uNDF30t before silage, indicating positive qualities. However, after ensiling its quality diminished, no longer maintaining its good positioning. Additionally, the increase in digestibility of this hybrid was the lowest in relative terms. Conversely, some hybrids demonstrated a remarkable ability to retain their quality, thereby emerging as the top performers after silage (e.g., 6152D1). This report aids farmers in understanding the changes in the quality of dual-purpose corn before and after ensiling, highlighting the importance of considering the quality variables when selecting hybrids. Future research should focus not only on the quality performance of dual-purpose hybrids but also on the ensiling process to comprehend the mechanisms behind these changes in quality.

Acknowledgments

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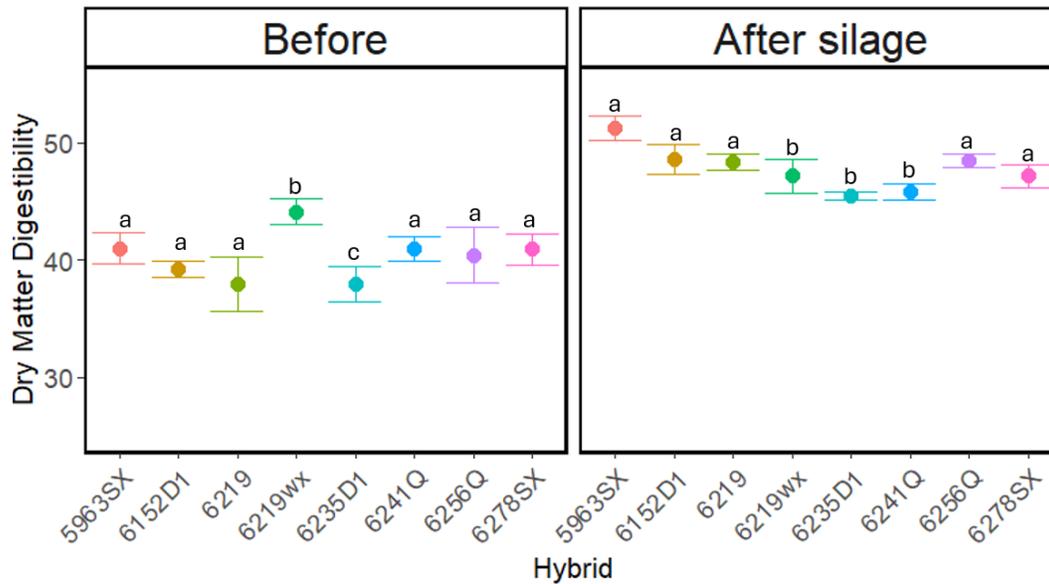
Figure 1. Comparison between the average values of dry matter digestibility (DMD) before and after silage. The vertical lines represent the standard deviation. Different letters represent significant differences among the groups.
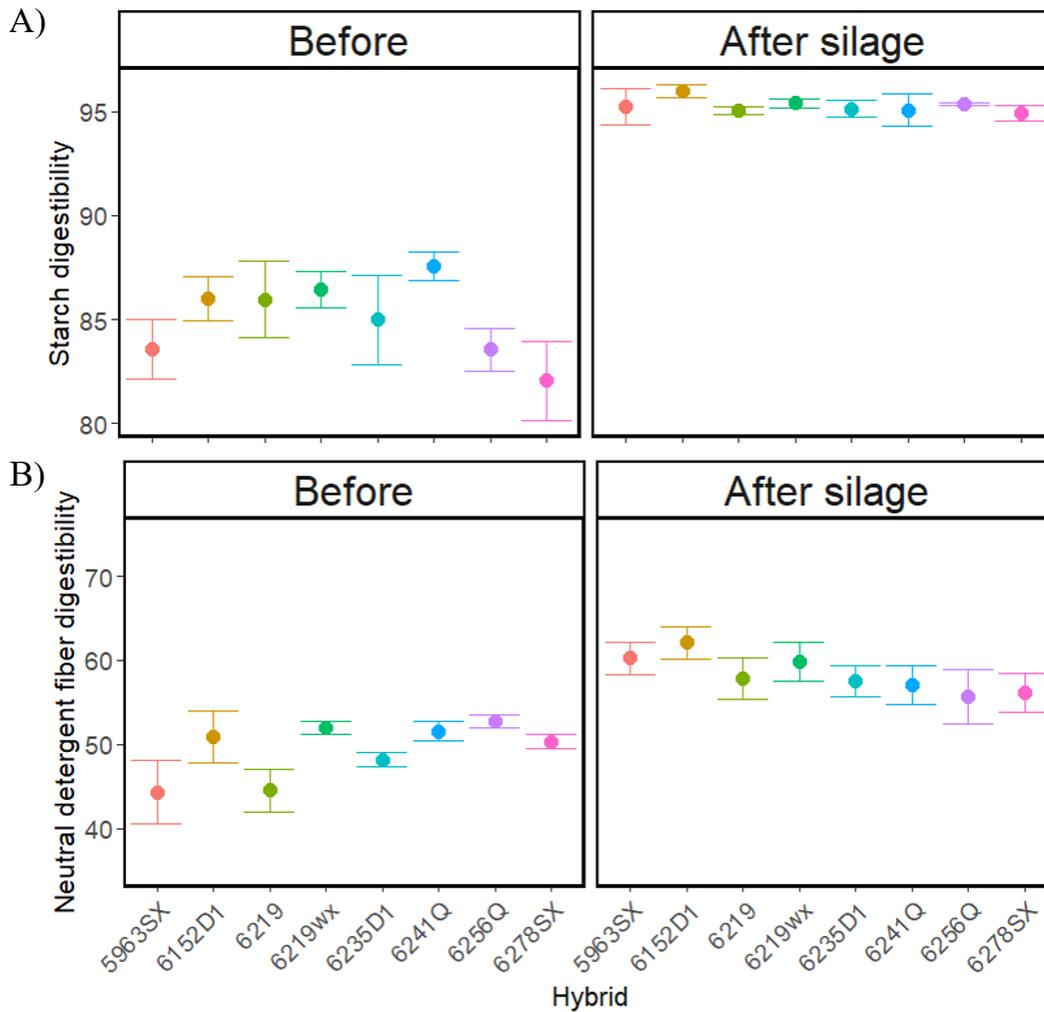
Figure 2. A) Starch digestibility after 7 hours as function of the hybrids B) Neutral detergent fiber digestibility as a function of the hybrids. The vertical lines represent the standard deviation.
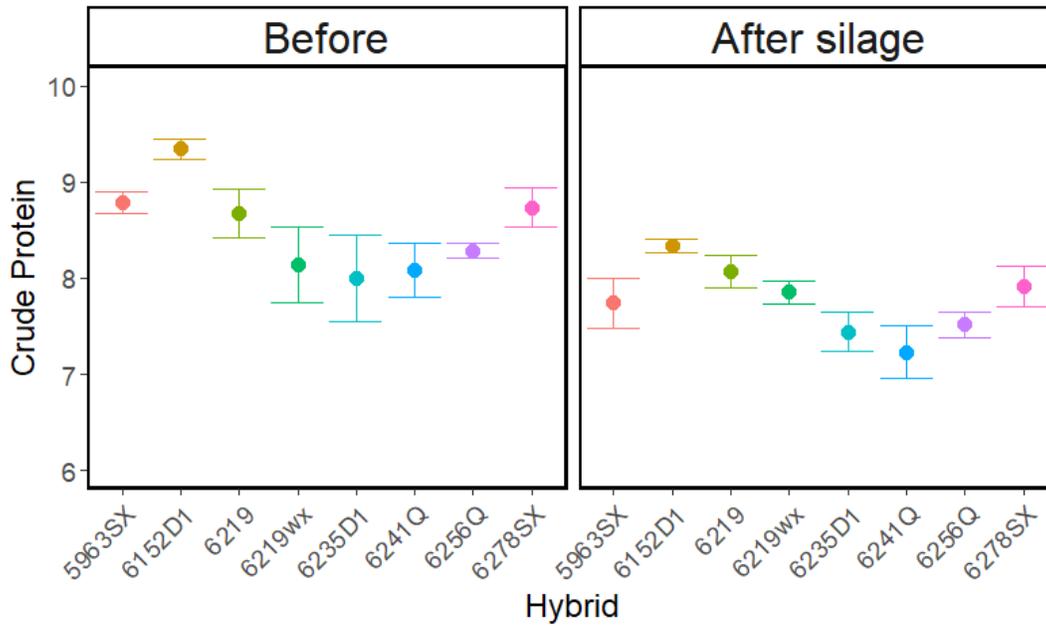
Figure 3. Comparison between the average values of crude protein (CP) before and after ensiling. The vertical lines represent the standard deviation.
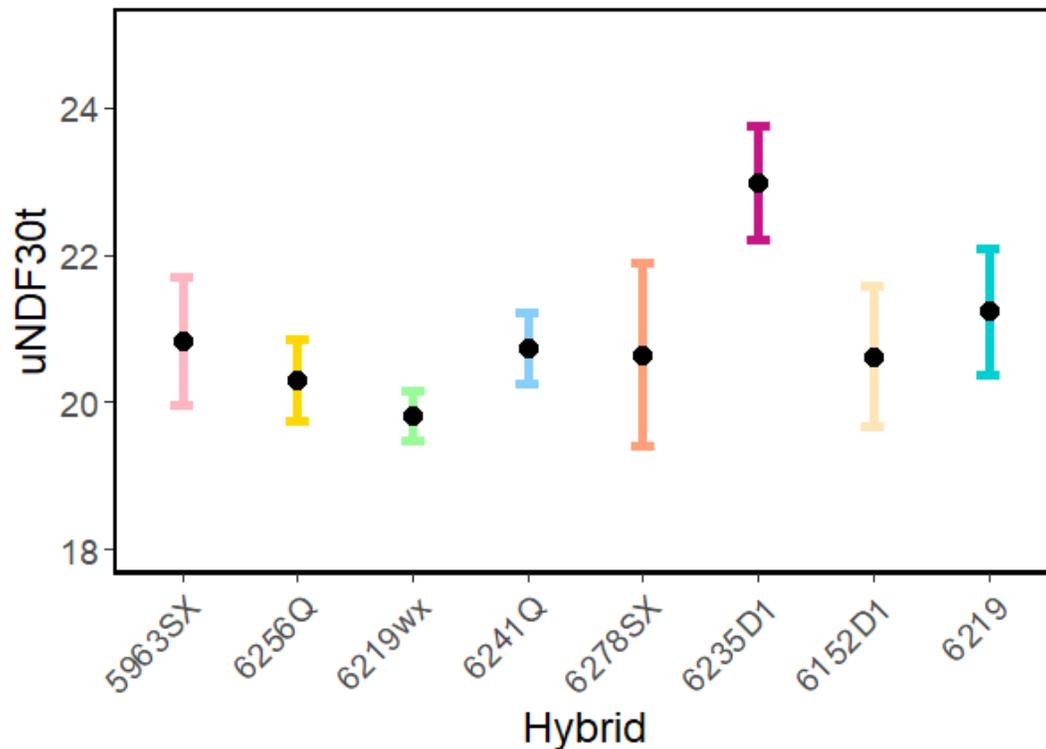

Figure 4. Neutral detergent fiber undigestible (uNDF30t) in 30 hours method. The vertical lines represent the standard deviation.
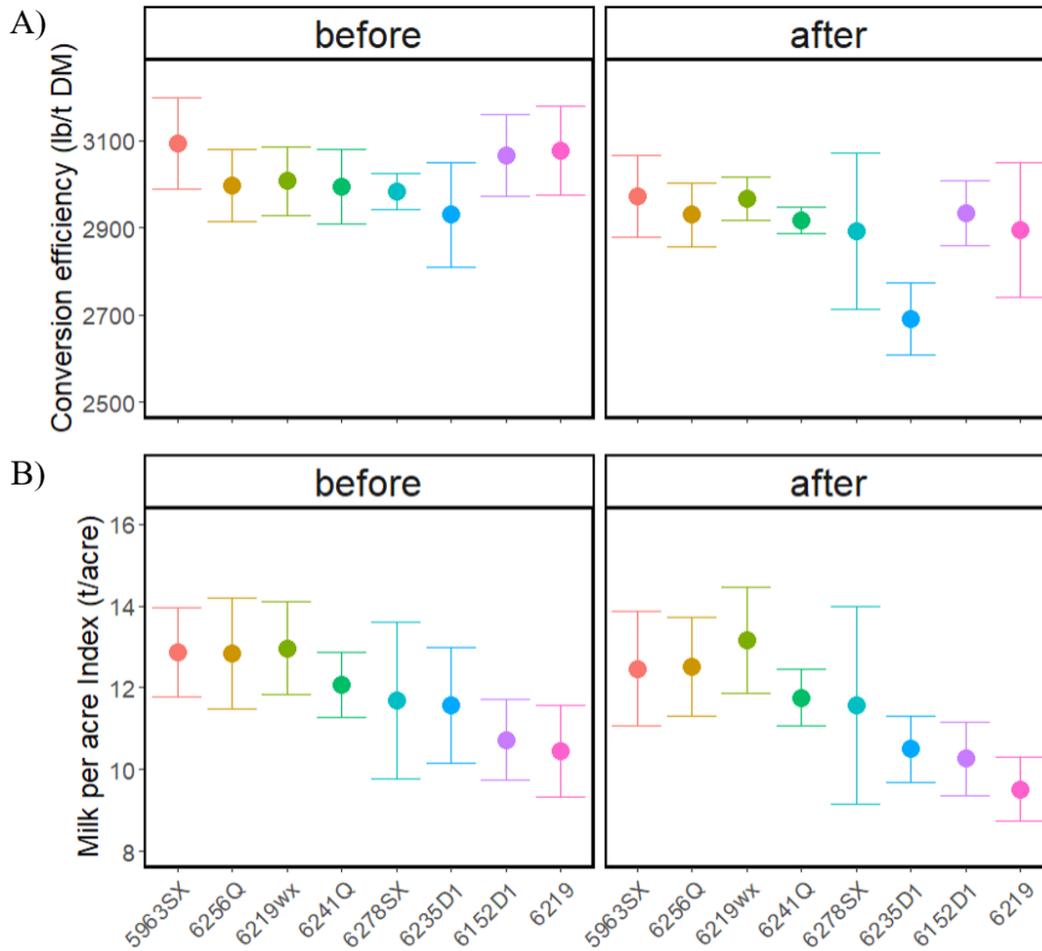
Figure 5. A) Conversion efficiency of each hybrid before and after silage (lb/t DM).
B) Milk per acre Index of each hybrid before and after silage (t/a). The vertical lines represent the standard deviation.