IMPACT OF AN OXYGEN BARRIER FILM ON THE PRESERVATION AND PREDICTED FEEDING VALUE OF WHOLE-PLANT CORN SILAGE

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Abstract

This study evaluated the effects of a high-performance oxygen barrier (oxygen transmission rate < 0.4 $cm^3/m^2/24$ h; DIN 53380-3) on nutritive value, and estimated milk production of whole-plant corn silage produced on a commercial dairy farm in Brazil. Corn was harvested in early February (DM, CP, NDF, ADF, starch and ash concentrations; 349, 82.9, 407, 224, 271 and 41.3 g kg^{-1}, respectively) and ensiled in two bunker silos (60 × 12 × 1.8 m; length × width × height), which were sealed using a standard polyethylene (PE) and an oxygen barrier (OB) + PE cover. Samples were collected at 64, 103, 164, and 178 days after ensiling from three locations on the silo face: 25 cm below the surface under each cover type and from the center of the silo at 100 cm from the floor. Samples were analyzed for chemical composition, and the estimated milk yield/ton of silage was calculated. Data were analyzed using the MIXED procedure of SAS. Silage sealed with the OB showed greater dry matter and starch concentrations and lower fiber fractions (neutral detergent fiber, acid detergent fiber, and lignin) compared with PE-sealed silage ($P < 0.05$). Furthermore, predicted milk production, estimated using the Milk2006 and Milk2024 models, was greater for OB than for PE silages (1641.4 vs. 1598.3 kg/ton and 1589 vs. 1543 kg/ton; $P < 0.05$). These results demonstrate that the use of a high-performance oxygen barrier improves preservation of whole-plant corn silage nutritive value and enhances predicted milk yield per ton of silage.

Keywords: Commercial farm, High-performance oxygen barrier film, Milk2024

INTRODUCTION

Forages are the backbone of most ruminant livestock operations, and preserving forage yield and quality in the form of silage is essential to ensure a consistent feed supply in such systems. As the product of a fermentation process, silage requires a strict anaerobic environment to occur efficiently, preserving ensiled dry matter (DM) and forage quality. Although oxygen barrier films (OB) have been tested and used for the past 25 years (Degano, 1999), conventional polyethylene films are still widely used by farmers around the world due to their availability and low cost. Their relatively high oxygen permeability can compromise silage quality by promoting aerobic spoilage, which leads to dry matter (DM) losses, reduced nutrient preservation, and consequently lower animal performance. Oxygen barrier films are designed to significantly reduce oxygen transmission rates (OTR), creating an environment more conducive to optimal fermentation, reducing dry matter (DM) losses and extending aerobic stability (Wilkinson & Fenlon, 2014). A recent study has shown the benefits of high-performance oxygen barriers in experimental-scale silos (Amaro *et al.*, 2025), but few have evaluated these novel technologies under large-scale commercial conditions. Thus, our objective was to compare two sealing systems in large-scale silos on a commercial dairy farm in Brazil on nutrient preservation and predicted animal performance.

MATERIAL AND METHODS

Whole-plant corn (*Zea mays*) was harvested in early February after approximately 112 days after sowing (DM, CP, NDFom, ADF, starch and ash concentrations; 349, 82.9, 407, 224, 271 and 41.3 g kg^{-1}, respectively) on a commercial dairy farm in Brazil and ensiled in two bunker silos (60 × 12 × 1.8 m; length × width × height). Each silo was sealed using a standard polyethylene (PE, white-on-back 150 µ) and a high-performance oxygen barrier film (OB; Passion Yellow, 45 µ, OTR < 0.4 $cm^3/m^2/24$ h; DIN 53380-3) + PE cover. Samples were collected over time at 64, 103, 164, and 178 days after ensiling from three locations on the silo face: 25 cm below the surface under each cover type and from the center of the silo at 100 cm from the floor. Samples were analyzed for chemical composition using NIRS, and the estimated milk yield/ton of silage DM was calculated. Data were analyzed using the MIXED procedure of SAS.

RESULTS AND DISCUSSION

Preserving silage yield and digestible nutrients is essential for achieving greater animal performance. High-performance oxygen barriers can reduce oxygen ingress into the silo and, consequently, decrease aerobic losses, which are often most pronounced in the top layer of silos. Thus, we evaluated two silage sealing strategies to determine nutrient preservation and estimate animal performance under real farm conditions. Sealing strategy did not affect the fermentation profile of silages (pH = 3.89, lactic acid = 48.5 g kg^{-1}, acetic acid = 37.7 g kg^{-1}, butyric acid = not detected, and ammonia-N = 99.5 g kg^{-1}; $P > 0.10$). Treatment means for silage chemical composition are presented on Table 1, while Table 2 presents the estimated milk yield using two prediction equations. Silage sealed with OB showed greater dry matter concentration when compared to PE (327 vs. 341 g kg^{-1}, $P = 0.05$), suggesting improved DM preservation. This is consistent with the fact that aerobic deterioration leads to the oxidation of nutrients, producing CO_2, water, and heat, which reduces overall silage DM content (McDonald *et al.*, 1991) and the lower ash concentration observed in OB sealed silage compared to PE (39.1 vs. 36.0 g kg^{-1}, $P < 0.05$). Greater fiber fractions (NDFom, neutral detergent fiber; ADF, acid detergent fiber; and lignin) were observed in PE compared with OB-sealed silage ($P < 0.05$), possibly due to the greater loss of more digestible nutrients, such as starch, during aerobic deterioration. Starch concentrations were greater for OB when compared to PE (299 vs. 281 g kg^{-1}; $P = 0.05$) indicating reduced deterioration of this nutrient. Furthermore, predicted milk yield per ton of silage DM, estimated using the Milk2006 and Milk2024 models, were greater for OB than PE silages, regardless of the model used (1641.4 vs. 1598.3 kg/ton and 1589 vs. 1543 kg/ton; $P < 0.05$). The increased milk yield is likely due to the greater concentration of more digestible nutrients, such as starch, and the lower fiber content observed in OB sealed silage. Overall, Core samples showed similar chemical composition and estimated milk yield to OB-treated silage. These results demonstrate that the use of a high-performance oxygen barrier improves the preservation of whole-plant corn silage nutritive value and enhances predicted milk yield per ton of silage compared with a PE system.

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Tab. 1: Chemical composition of whole-plant corn silage sealed with conventional polyethylene film or a high-performance oxygen barrier in a commercial dairy farm

Item	Core	PE	Combo	SE	P-value
Dry matter, g kg^{-1} fresh weight	348^{a}	327^{b}	341^{a}	13.6	0.05
Starch, g kg^{-1} DM	296^{ab}	281^{b}	299^{a}	25.7	0.05
Crude protein, g kg^{-1} DM	80.6	85.2	81.5	2.45	0.15
NDFom, g kg^{-1} DM	373^{b}	385^{a}	360^{c}	22.8	0.01
ADF, g kg^{-1} DM	224^{b}	231^{a}	210^{c}	16.3	0.03
Lignin, g kg^{-1} DM	38.6^{ab}	40.8^{b}	37.1^{a}	2.24	0.02
Ether extract, g kg^{-1} DM	31.4	31.1	30.2	1.43	0.74
Ash, g kg^{-1} DM	38.2^{ab}	39.1^{a}	36.0^{b}	1.14	0.04

Means with different superscript letters within a line differ significantly (P < 0.05).

Tab. 2: Estimated milk yield of whole-plant corn silage sealed with conventional polyethylene film or a high-performance oxygen barrier in a commercial dairy farm

Item	Core	PE	Combo	SE	P-value
Estimated milk yield using Milk2006, kg ton^{-1}	1653.5^{a}	1598.3^{b}	1641.4^{a}	16.5	0.04
Estimated milk yield using Milk2024, kg ton^{-1}	1566.1^{ab}	1543.0^{b}	1589.0^{a}	23.4	0.01

Means with different superscript letters within a line differ significantly (P < 0.05).

CONCLUSION

In conclusion, the use of a high-performance oxygen barrier is an effective strategy to improve silage preservation under real farm conditions. By reducing oxygen ingress, OB films help minimize dry matter and nutrient losses, resulting in corn silages with higher starch content and and greater feeding value. This translates into improved efficiency of milk production per ton of silage, making OB sealing a valuable tool for enhancing both silage quality and overall dairy farm performance.

REFERENCES

Amaro, F. X., G. Copani, and S. Wigley. 2025. Effects of oxygen barriers on losses, fermentation and microbial counts of sorghum silage. In: *Conference Proceedings the XX Int. Silage Conference*. Gainesville, FL, USA, July 2025.

Borreani, G. I., Tabacco, E. R., Schmidt, R. J., Holmes, B. J., Muck, R. A. 2018. Silage review: Factors affecting dry matter and quality losses in silages. *Journal of dairy science.* 101(5), 3952-79.

Degano, L. 1999. Improvement of silage quality by innovative covering system. In: *Conference Proceedings the XII Int. Silage Conference*. Uppsala, Sweeden, 5-7 July.

McDonald, P., Henderson, A. R., S., Heron, S. J. E.. 1991. *The biochemistry of silage*. 2nd Edition. Chalcombe, Marlow, UK.

Wilkinson, J. M., Fenlon. J. S. 2014. A meta-analysis comparing standard polyethylene and oxygen barrier film in terms of losses during storage and aerobic stability of silage. *Grass and Forage Science.* 69(3), 385-392.

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