http://dx.doi.org/10.1590/1678-4162-12248

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Arq. Bras. Med. Vet. Zootec., **v.73, n.3, p.711-720, 2021**

Effect of sealing on the feed out face of trench silos on the performance of confined calves

[*Efeito da vedação na porção inicial de silos trincheiras sobre o desempenho de novilhos confinados*]

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ABSTRACT

This study aimed to evaluate the productive performance, dry matter intake, apparent digestibility and ingestive behavior of feedlot calves fed corn silage from the feed out face of trench silos with different types of sealing. The animals were divided into three treatments with four repetitions: Conventional seal - double-sided polyethylene of 110µm thickness; Double-sided seal - double-sided polyethylene of 200µm thickness; and Double seal - composed of double face polyethylene with a thickness of 80µm superimposed on a polyamide translucent vacuum film with a thickness of 20µm. The use of double face sealing provided 12.63% increase in average daily gain and improved food conversion by 0.62 percentage points. The apparent digestibility of the diet with double-face sealing system silage was 4.30% higher than the diet with double-face sealing silage and 11.00% higher than the diet with conventional sealing silage. It is recommended to use the double face sealing with 200µm polyethylene and double face sealing with 80µm thick polyethylene on top of a 20µm thick polyamide translucent vacuum film.

Keywords: ingestive behavior, plastic film, feed efficiency, weight gain, polyethylene

RESUMO

Objetivou-se avaliar o desempenho produtivo, o consumo de matéria seca, a digestibilidade aparente e o comportamento ingestivo de novilhos confinados, alimentados com silagem de milho da porção inicial de silos do tipo trincheira, conservada sob distintos tipos de vedação. Os animais foram divididos em três tratamentos, com quatro repetições: vedação convencional - polietileno tipo dupla face, com espessura de 110µm; vedação dupla face - polietileno tipo dupla face, com espessura de 200µm; e dupla vedação - polietileno tipo dupla face, com espessura de 80µm sobreposto a um filme vácuo translúcido de poliamida, com espessura de 20µm. O uso da vedação dupla face proporcionou incremento de 12,63% no ganho de peso médio diário e melhorou em 0,62 ponto percentual a conversão alimentar. A digestibilidade aparente da dieta com silagem do sistema de vedação dupla face foi 4,30% superior em relação à dieta com silagem da dupla vedação e 11,00% superior à dieta com silagem da vedação convencional. Recomenda-se a utilização tanto da vedação dupla face com polietileno de 200µm quanto da dupla vedação com polietileno tipo dupla face, com espessura de 80µm, sobreposto a um filme vácuo translúcido de poliamida com espessura de 20µm.

Palavras-chave: comportamento ingestivo, filme plástico, eficiência alimentar, ganho de peso, polietileno

INTRODUCTION

The type of sealing used in corn silage production has a great importance for an adequate fermentation, which is carried out by lactic acid bacteria that convert soluble sugars into organic acids, such as lactic acid, under anaerobiosis, which influences the preservation of the nutritional quality of ensiled material. Therefore, the adequate sealing of a corn silage can minimize the loss of nutrients and that the chemical composition and digestibility of the original material are preserved (Borreani *et al*., 2007; Neumann *et al*., 2017). For a proper fermentation, it is essential to achieve anaerobic

Recebido em 24 de novembro de 2020
Aceito em 24 de fevereiro de 2021
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conditions (Wilkinson and Davies, 2013). However, for several reasons, such as poor material quality, low thickness, high permeability of the plastic film and perforations caused when closing the silo or during the storage period, make it difficult to achieve anaerobiosis inside the silo (Borreani *et al*., 2007; Bernardes *et al*., 2012).

In general, sealing must be uniform throughout the silo, but there is greater difficulty in compacting and correctly sealing the lateral and feed out faces (ramp) of the trench silo, making them more prone to deterioration, due to greater exposure to the external environment and temperature fluctuations, making the environment conducive to the action of aerobic microorganisms that promote spoilage of ensiled forage (Kung Junior, 2005; Bernardes, 2016). Many nutritionists decide to discard these portions of the silo for considering them of poor quality, low animal response and high health risk to animals regarding the real situation of the rest of the silo.According to Neumann *et al*. (2018), the type of material used to seal the silo can positively affect the preservation of silage, resulting in higher productive performance of the animals, stimulating the daily dry matter intake and allowing less participation of the concentrated fraction in the diets. Plastic films based on double-sided polyethylene (white on black) are still the most used material to cover trench silos in Brazil (Bernardes *et al*., 2015), films with thickness ranging from 80 to 120µm are the most common.

However, the demand for cover that maintain an anaerobic environment and with less temperature fluctuation inside the silo has stimulated the development of plastic films with less permeability to oxygen and UV rays and greater mechanical resistance, which allows the efficient preservation of the ensiled mass and reduces nutrient losses during fermentation (Borreani *et al*., 2007). Based on this purpose, the present study aimed to evaluate the productive performance, dry matter intake, apparent digestibility and ingestive behavior of feedlot steers fed corn silage from the feed out face of trench silos preserved using different types of sealing.

MATERIAL AND METHODS

The experiment was conducted at the Animal Production Center (NUPRAN) of the Agricultural and Environmental Sciences Sector, State University of the midwest (UNICENTRO), municipality of Guarapuava, State of Paraná. All experimental procedures were previously submitted to the Committee for Ethics in Animal Experimentation (CEUA) of UNICENTRO and approved for execution (Official Letter 021/2018). Corn (*Zeamays*, L.) was planted on 02/11/2017, using seeds of the early cyclehybridmaximus Viptera 3 (Syngenta®), with the purpose of producing grains and silage, with hard textured grains and resistance to Glyphosate.

Under no-till farming, seeds were sown in rows spaced 0.80m apart, 0.04m sowing depth and distribution of 5 seeds per linear meter, for a final population of 62.5 thousand plantsha^{-1}. Corn plants were harvested at 145 days after emergence at a kernel dough stage, with the aid of a precision forage harvester JF®model (C-120 AT S2), to an average particle size of 10mm. The material collected for each treatment was stored in 12 trench silos, with 15m in length, 1.2m in width and 1.2m in eighth. The opening of the same occurred simultaneously, 75 days after ensiling, and the handling for silo unloading occurred for 35 days removing only the initial face of the silo (ramp), with a daily removal of 0.15m.

Twenty-four calves, ½ Angus Nellore blood, whole males, from the same herd, with an average initial weight of 300 kg and an average age of 10months, were previously adapted to the diets and feedlot management on the farm of origin. The animals were housed in 12 feedlot pens, semi-roofed, with an area of $15m^2$, with a concrete feeder and a water trough regulated by an automatic float. They were previously dewormed and selected from a herd based on body weight and condition and then distributed in a completely randomized experimental design, consisting of three treatments: T_1 Conventional seal- corn silage preserved with double-sided polyethylene of 110µm thickness; T_2 Double-sided seal- corn silage preserved with double-sided polyethylene of 220µm thickness; and T3 Double seal- corn silage preserved with oxygen-impermeable film composed of double-sided

polyethylene of 80µm thickness on a translucent vacuum polyamide film of 20µm thickness, with four repetitions each, where each repetition consisted of a silo and/or a pen with two animals.

The conventional seal consisted of using double-sided (Plus Agrolord®) polyethylene plastic film, 110µm thick, from the company Basso Pancote, Brazil. The double-sided seal consisted of using a double-sided plastic film (polyethylene with a thickness of 200µm, from the company Carga Pesada, Brazil). In the double seal treatment, we used the plastic film (Polydress® O_2 Barrier 2IN1, which has a layer of 80 µm of a protective film of polyethylene, overlaid on a layer of translucent vacuum polyamide film with 20 µm thickness, which ensures impermeability to oxygen, from RKW, Germany). The experiment lasted for 35 days, 5 days for adaptation of animals to diets and facilities and two periods of evaluation with 15 days each.

Food management was carried out twice a day (6h and 1.6h) and consumption was recorded daily, by means of the difference in weight between the amount supplied and leftovers from the previous day. The supply adjustment was carried out daily, aiming at an "ad libitum" offer, considering 5% leftovers, on a dry matter basis of the diet. During the feedlot period, samples of corn silage and concentrate were taken for analysis of the chemical composition of the diet (Table 1). Samples were dried in a ventilated oven at 55 °C to constant weight, and sequentially ground in a Wiley mill with a 1mm sieve.

The contents of dry matter (DM), crude protein (CP), mineral matter (MM) and ether extract (EE) were determined according to AOAC (Official…, 1995). The content of neutral detergent fiber (NDF) was obtained according to the method of Van Soest *et al*. (1991) with thermostable α-amylase and acid detergent fiber (ADF) and lignin (LIG) contents were determined according to Goering e Van Soest (1970). The coefficient of total digestible nutrients (TDN) was calculated according to Weiss *et al*. (1992).

The diets consisted of the three corn silages, from different types of sealing, at a constant ratio of 40% forage (corn silage from different types of sealing) and 60% concentrate, on a dry matter basis (Table 1). The concentrate was prepared in the commercial feed factory of Cooperative Agrária (Guarapuava, Paraná, Brazil), formulated based on soybean meal (4.00%), corn (13.70%), wheatmeal (25.00%), soybean husk (4.00%), malt root (21.00%), barley (15.00%), corn germ (10.40%) calcitic limestone (3.60%), dicalcium phosphate (0.50%), livestock urea (1.50%), common salt (0.60%), and mineral vitamin premix (0.70%), in pellets. The chemical composition of the concentrate showed average values of 90.40% dry matter, 6.36% mineral matter, 20.20% crude protein, 2.05% ether extract, 31.47% neutral detergent fiber, 13.08% acid detergent fiber, 4.73% lignin, 78.68% total digestible nutrients, 1.67% Ca and 0.58% P, based on total dry matter and with guarantee levels of premix per kg concentrate of vit. A of 16,000 IU, vit D3 of 2,000 IU, vit. E 25 IU, S 0.36 g, mg 0.74 g, Na 3.6 g, Co 0.52mg, Cu 22.01mg, I 1.07mg, mn 72.80mg, Se 0.64mg and Zn 95.20mg.

Feedlot steers fed corn silages from the feed out face of trench silos with different types of sealing were evaluated for dry matter intake, animal performance, apparent digestibility, ingestive behavior and in situ ruminal disappearance rate. Animals were weighed at the beginning, in the middle and at the end of the experiment, after solid fasting for 10hours, to determine the average daily weight gain (ADG). The daily dry matter intake, expressed in kg day^{-1} (DMI, kg day^{-1}) or expressed as a percentage of body weight (DMI, BW%) was measured through the difference between the daily amount of food supplied and the number of leftovers from the previous day. To determine feed conversion (FC), the ratio of the average daily dry matter intake to the average daily weight gain obtained in the evaluation period ($DMI_{Kgday\text{-}1}$ ADG^{-1}) was calculated.

In the middle of the feedlot period, the total feces from each experimental unit were collected for 48 consecutive hours. Feces were weighed and sampled at the end of each six-hour shift. Subsequently, they were dried in a ventilation oven at 55 °C to constant weight and ground in a Wiley mill with a 1mm sieve. This procedure allowed the determination of the fecal dry matter content, and sequentially estimation of the total fecal output on a dry matter basis, expressed in kg day^{-1} dry matter. To estimate the apparent

digestibility of dry matter (DMS), homogeneous samples of the diet and feces were taken for analysis. The DMS, expressed in g kg^{-1} DM, was calculated using the formula: Digestibility {1-[(nutrient ingested - nutrient excreted) ÷ nutrient ingested]} x 100.

Table 1. Chemical composition of silages and experimental diets

Type of sealing- Corn silage			
Chemical composition	Conventional Seal	Double Sided	Double Seal
Dry matter, %	41.22	42.58	42.83
Mineral matter, % DM	2.91	3.36	2.71
Crude protein, % DM	6.01	6.72	6.06
Neutral detergent fiber, % DM	54.86	51.33	53.36
Acid detergent fiber, % DM	29.23	27.06	28.98
Lignin, % DM	6.96	6.66	6.56
Total digestible nutrients, %	67.38	68.90	67.55
	Type of sealing - Experimental diets		
Chemical composition	Conventional Seal	Double Sided	Double Seal
Dry matter, %	70.73	71.27	71.37
Mineral matter, % DM	4.98	5.16	4.90
Crude protein, % DM	14.52	14.81	14.54
Neutral detergent fiber, % DM	40.83	39.41	40.23
Acid detergent fiber, % DM	19.54	18.67	19.44
Lignin, % DM	5.62	5.50	5.46
Total digestible nutrients, %	74.16	74.77	74.23

Observations of the ingestive behavior were made for 48h, by four observers per shift, in a rotation system every 6h. The readings were taken at regular intervals of 3min. the ingestive behavior was represented by idle, rumination, water intake and food intake activities, expressed in hours day^{-1}. In addition, we observed the frequency of the occurrence of feeding, watering, urination and defecation activities, expressed in number of times per day, following the same methodology. In the night observation, the environment was maintained with artificial lighting. During the 30 experimental days, feces of each pen were evaluated daily by means of visual observation scores.

Feces were classified by scores, ranging from 1 to 6, in which: 1 = liquid feces, mushy; 2 = liquid feces, mushy, with small piles of up to 2.5cm; 3 = intermediate feces with concentric ring and 3 to 4cm pile; 4 = pasty feces with concentric ring and pile of more than 5cm; 5 = drier stools without concentric ring and pile greater than 5cm; 6 =hardened or dried stools, based on the methodology adapted from Looper *et al*. (2001) and Ferreira *et al*. (2013).

Besides the ranking of feces scores, a visual assessment of dietary leftovers was also performed daily in relation to the proportion of corn silage and concentrate, on a dry matter basis. The leftovers were ranked using visual scores, from 1 to 5, with 1 = 60% silage and 40% concentrated; 2 = 50% silage and 50% concentrate 3 = 40% silage and 60% concentrate; 4 = 30% silage and 70% concentrate; 5 = 20% silage and 80% concentrate; and 6 = 10% silage and 90% concentrate, on a dry basis. The ruminal disappearance rate of dry matter and neutral detergent fiber of silages was estimated using the in-situ technique according to the methodology by Nocek (1988). The incubation times for determining the ruminal disappearance rate of dry matter and neutral detergent fiber were 0, 6, 12, 24, 36 and 48h, in reverse order of incubation time.

Data on performance, apparent digestibility and ingestive behavior were tested by ANOVA, with subsequent comparison of means by Tukey's test at 5% significance, using the GLM procedure of SAS (1993). The following statistical model was used: $Yi = \mu + Ti + Ei$, where: Yi = response criterion; μ = overall mean common to all observations (constant); Ti = effect of the i-th treatment; and Ei = random error inherent in all observations. The data collected regarding the ruminal disappearance rate of DM and NDF

were also subjected to polynomial regression analysis, using the "proc reg" procedure (SAS, 1993).

RESULTS AND DISCUSSION

The treatment of double-sided sealing provided corn silage with better quality, and feedlot steers fed this silage showed an increase of 12.63% (P <0.05) in the ADG in relation to the animals that received the silage from the conventional sealing (1.892 kg day^{-1} against 1.653 kg day^{-1}, respectively), the steers that were given silage from the double seal had intermediate ADG and not different (P> 0.05) from the other types of sealing (Table 2).

Table 2. Average daily gain, daily dry matter intake, feed conversion and ingestive behavior regarding aspects of feeder and feces scores of feedlot steers fed corn silage from the feed out face of trench silos with different types of sealing associated with feedlot period

Types of sealing	Silage emptying phase		Mean
	1st Period 1-15 days	2nd Period 16-30 days	
	Average daily gain, kg day^{-1}		
Conventional Seal	1.428	1.878	1.653 B
Double Sided	1.756	2.028	1.892 A
Double Seal	1.439	2.044	1.742 AB
Mean	1.541 b	1.983 a	
	Dry matter intake, kg day^{-1}		
Conventional Seal	7.39	8.29	7.84 A
Double Sided	7.62	8.24	7.93 A
Double Seal	7.38	8.36	7.87 A
Mean	7.46 b	8.30 a	
	Dry matter intake , % body weight		
Conventional Seal	2.29	2.36	2.32 A
Double Sided	2.35	2.32	2.33 A
Double Seal	2.27	2.35	2.31 A
Mean	2.30 a	2.34 a	
	Feed conversion (DMI ADG^{-1})		
Conventional Seal	5.57	4.47	5.02 A
Double Sided	4.69	4.11	4.40 B
Double Seal	5.30	4.12	4.71 AB
Mean	5.19 a	4.23 b	
	Daily feedlot score		
Conventional Seal	2.16	2.53	2.35 A
Double Sided	2.20	2.20	2.20 A
Double Seal	1.86	2.17	2.02 A
Mean	2.07 a	2.31 a	
	Daily feces score		
Conventional Seal	2.98	2.86	2.91 A
Double Sided	3.06	3.04	3.07 A
Double Seal	3.11	3.02	3.06 A
Mean	3.06 a	2.98 a	

Averages, followed by lowercase letters on the line, differ by F Test at 5%.
Averages, followed by upper case letters in the column, differ from each other by the 5% Tukey Test.

Neumann *et al*. (2018) compared different types of sealing and also found the influence of plastic film in sealing of trench silos on the ADG of feedlot steers, presenting results similar to those obtained herein. These authors verified ADG of 1.810 kg day^{-1} for animals that received silage covered with double seal and 1.565 kg day^{-1} for animals fed silage sealed with conventional film. Permeability to O_2 of plastic film is a crucial factor in maintaining the anaerobic environment inside the silo, especially in portions of the silo with greater exposure to the external

environment, like the sides and the ramp, directly impacting the final quality of the ensiled material and in the productive performance of animals (Bernardes *et al*., 2012; Neumann *et al*., 2018).

The DMI (kg day^{-1}) and DMI (BW%) of feedlot steers fed corn silage from the feed out face of trench silos were not affected by the different types of sealing (P> 0.05). This differs from that reported by Neumann *et al*. (2018), who compared double seal and conventional seal, and found that the double seal resulted in greater DMI (kg day^{-1}) (10.04 kg day^{-1} against 9.28 kg day^{-1}) and DMI (BW%) (2.30% against 2.21%), due to the better acceptance of silage by animals, as there was no selection or predilection for the concentrate fraction of the diet.

The greater availability of digestible fractions of NDF favors the efficiency of use of the forage offered, contributing to raise the ADG, which is only achieved when there is maintenance of the anaerobic environment inside the silo during fermentation (Neumann *et al*., 2018). Like ADG, FC was influenced by the type of sealing (P> 0.05). The animals fed silage from the double-sided treatment showed better feed conversion (4.40) than those that received silage preserved from the conventional sealing (5.02), a result justified by the superior ADG (Table 2) of the double-sided sealing, allowing to clearly demonstrate the influence of the type of sealing on the productive performance of confined steers. To achieve a greater ADG, the animals did not need to consume a greater amount of dry matter daily, showing the best use of the roughage fraction of the diet, since the concentrate fraction of the diet was constant throughout the evaluation period for all treatments.

Regarding the feedlot periods (Table 2), regardless of the type of sealing, there was an increase in the ADG (P <0.05), from the first to the second period (1.541 kg day^{-1} against 1.983 kg day^{-1}), which can be justified by the increase in the DMI (kg day^{-1}) (P <0.05), from 7.46 kg day^{-1} to 8.30 kg day^{-1}, showing that as the silage unloading advanced into the silo there was a productive increase of the animals, due to better conditions of preservation of the ensiled material in relation to the beginning of the feed out face of the silo. The ingestive behavior of the animals was not affected by the type of sealing and/or the evaluation period (P> 0.05) regarding the feeder and feces scores listed in Table 2, reinforcing that there was no preference for any fraction of the diet supplied to the animals, where scores closer to 3.00 were considered ideal.

The manure production of the animals was lower when fed silage covered with double-faced sealing (12.43 kg NM day^{-1} and 2.40 kg DM day^{-1}, respectively) in relation to those that received silage from the conventional sealing (15.84 kg NM day^{-1} and 2.85 kg DM day^{-1}, respectively), however, both did not differ (P> 0.05) from the double seal treatment (13.92 kg NM day^{-1} and 2.62 kg DM day^{-1}, respectively) (Table 3). Likewise, the apparent digestibility of DM for the diet of steers fed corn silage from the feed out of trench silos sealed with double-sided film was superior to the other types of sealing, being 4.30%higher than the apparent digestibility of the diet with silage from the double seal and 11.00%higher than the conventional seal, a result that shows the better animal performance achieved when using this type of sealing (Table 2), demonstrating the best use of the nutrients available in the diet.

Table 3. Average manure production, on natural and dry matter in kg day^{-1}, and apparent digestibility of feedlot steers fed corn silage from the feed out face of trench silos with different types of sealing

Types of sealing	Manure production kg NM day^{-1}	Manure production kg DM day^{-1}	Digestibility of DM %
Conventional Seal	15.84 A	2.85 A	61.80 C
Double Sided	12.43 B	2.40 B	69.44 A
Double Seal	13.92 AB	2.62 AB	66.74 B
Mean	14.06	2.62	65.99
Probability	0.0169	0.0479	0.0001
CV, %	11.84	10.73	2.42

Averages, followed by upper case letters in the column, differ from each other by the 5% Tukey Test.

According to Barros *et al*. (2011) the apparent digestibility of the diet is mostly dependent on the chemical characteristics of the food, since the fiber portion in general presents less digestibility due to a higher concentration of structural carbohydrates compared to concentrate foods, in addition to generating physical fill of the rumen, reducing the voluntary intake. However, the maintenance of the anaerobic environment inside the silo can promote greater preservation of digestible fractions of the fiber and provide better use by animals (Costa *et al*., 2005).

Neumann *et al*. (2018) state that the higher availability of digestible portions of the fiber fraction of the food allows greater digestibility and consequent improvement in the productive performance of confined animals, which is closely related to the ability of the plastic film to keep the environment strictly anaerobic and isolated from changes outside the silo. Thus, it is suggested that this justifies the result obtained in the present study, since the concentrate fraction of the experimental diets remained constant throughout the evaluation period for all types of sealing. Animals that received silage from the conventional seal spentmore hours day^{-1} ingesting food and water (3.19 and 0.33 hours day^{-1}, respectively) than those that were fed silage from double-sided seal (2.73 and 0.20 hours day^{-1}, respectively) (Table 4), which suggests that these animals fed conventional seal silage had less acceptability to forage and/or spent more time trying to select the diet.

Table 4. Ingestive behavior of activities related to food intake, water intake, rumination and idle, expressed in hours day^{-1}, and activities related to feeding, watering, defecation and urination, expressed in number of times day^{-1}, of feedlot steers fed corn silage from the feed out face of trench silos with different types of sealing

Ingestive Behavior	Types of sealing – Corn Silage			Mean	CV, %	Prob.
	Conventional Seal	Double Sided	Double Seal			
	Hours day^{-1}					
Food intake	3.19 A	2.76 B	2.78 AB	2.90	17.6	0.0499
Water intake	0.33 A	0.20 B	0.18 B	0.24	20.1	0.1049
Rumination	5.53 A	5.43 A	5.46 A	5.47	13.60	0.9732
Idle	15.00 A	15.68 A	15.58 A	15.42	6.1	0.4247
	Number of times day^{-1}					
Feeding	17.92 A	13.70 B	15.17 B	15.59	22.2	0.0315
Watering	6.50 A	4.40 B	4.75 B	5.21	28.7	0.0488
Defecation	7.00 A	6.90 A	6.00 A	6.63	25.3	0.7360
Urination	4.67 A	5.30 A	4.83 A	4.93	28.6	0.8228

Averages, followed by capital letters, on the line, differ by the Tukey Test at 5%.

As for the rumination and idle, expressed in hours day^{-1}, these did not suffer interference from the type of sealing (P> 0.05). The time spent on rumination activity is proportional to the cell wall content contained in the forage (Van Soest, 1994), a factor that had no influence on rumination time, since the experimental diets consisted of the same source of forage from the same cultivation area, the same forage: concentrate ratio and the same degree of processing of the particles as listed in Table 1. The animals fed the conventional seal silage spend more time in food and water ingestion, and also accessed the feeder and the feeder more frequently (17.92 times day^{-1} and 6.50 times day^{-1}, respectively) compared to those fed double-sided silage (13.70 times day^{-1} and 4.40 times day^{-1}, respectively) and those fed double seal silage (15.17 times day^{-1} and 4.75 times day^{-1}, respectively), which did not differ from each other (P> 0.05) (Table 4). Regarding the frequency of defecation and urination, there was no influence from the type of sealing (P> 0.05), with an average of 6.63 times day^{-1} and 4.93 times day^{-1}, respectively.

The time spent in feeding is related to the chemical characteristics of the diets, and foods with a higher concentration of soluble carbohydrates require less time for ingestion and chewing, but the presence of oxygen inside the silo during fermentation leads to consumption of non-structural carbohydrates (Missio *et al*., 2010; Oba and Allen, 2000). This fact may be related

to the lower capacity of the conventional seal to block the gas exchange between the internal and the external environment of the silo, reflecting in longer time and higher frequency in food and water intake of animals fed silage from this type of sealing.

It is noteworthy that the types of sealing influenced the ruminal disappearance rate of DM, so that the conventional seal silage presented the lowest rates of ruminal disappearance of DM (0.866%hour^{-1}), compared to the silage obtained from the double-sided and double sealing treatments (1.045%hour^{-1} and 1.052%hour^{-1}, respectively), with an average 17%higher than the ruminal degradation of DM in double-sided and double seal compared to conventional seal (Figure 1). After 48hours of incubation, silage covered with double-sided seal showed the highest ruminal disappearance rate (67.30%), while the silages of the double seal and the conventional seal had lower ($P < 0.05$) rates of ruminal disappearance (64.48% and 61.87%, respectively).

The preservation of the strictly anaerobic environment makes the fermentation process more efficient, resulting in the preservation of the characteristics of the original ensiled material, favoring better rumen degradability coefficients of DM, allowing to suggest that the silage of the double seal treatment provided the best preservation of the anaerobic environment, restricting the entry of O_2 into the silo during fermentation and feeding of the animals (Rooke and Hatfield, 2003). Figure 2 showed that the ruminal disappearance rate of NDF was similar between types of sealing, with values of 0.7709 %hour^{-1} for double seal silage, 0.7668%hour^{-1} for double-sided seal silage and 0.75591 %hour^{-1} for conventional seal silage. However, when analyzing the total incubation time of 48hours, the double-sided silage showed the greatest ruminal disappearance of NDF (44.60%) while silage of conventional seal showed a lower ruminal disappearance of NDF (42.73%).

According to Lopes *et al*. (2015), the digestion of the fiber portion of the food occurs mainly in the rumen and is the result of a dynamic process influenced by the chemical nature of the plant fiber and the rate of passage through the gastrointestinal tract of the animal. The rapid disappearance of NDF in the rumen is related to high fiber degradation and higher rate of passage, enabling greater voluntary intake of the food due to low physical fill of the rumen (Oba e Allen, 2000).

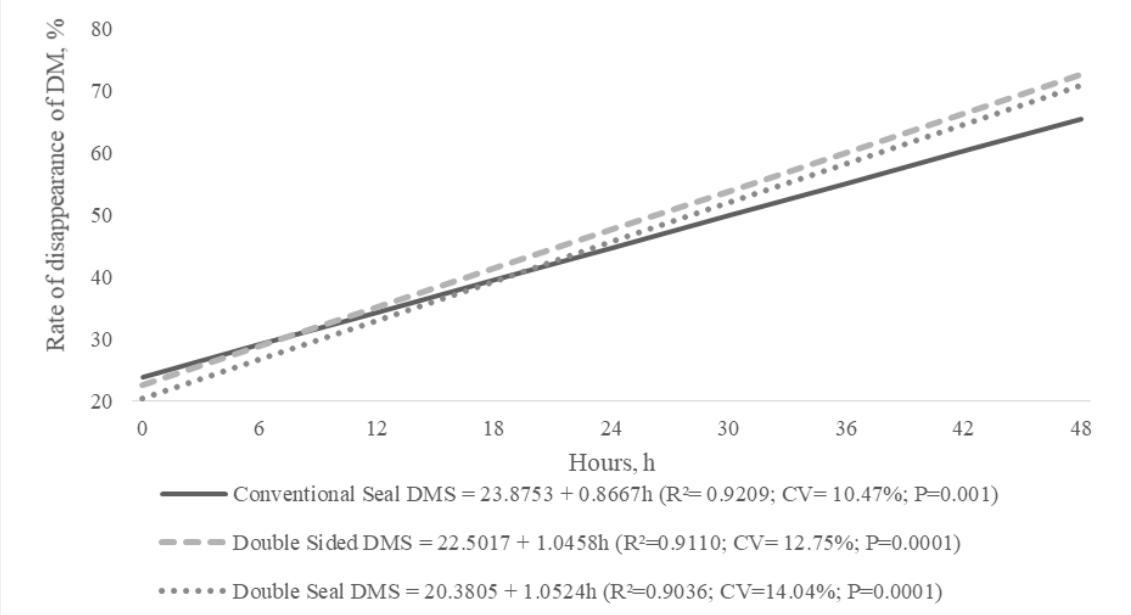

Figure 1. In situ ruminal dry matter disappearance rate of corn silage from the feed out face of trench silos with different types of sealing.

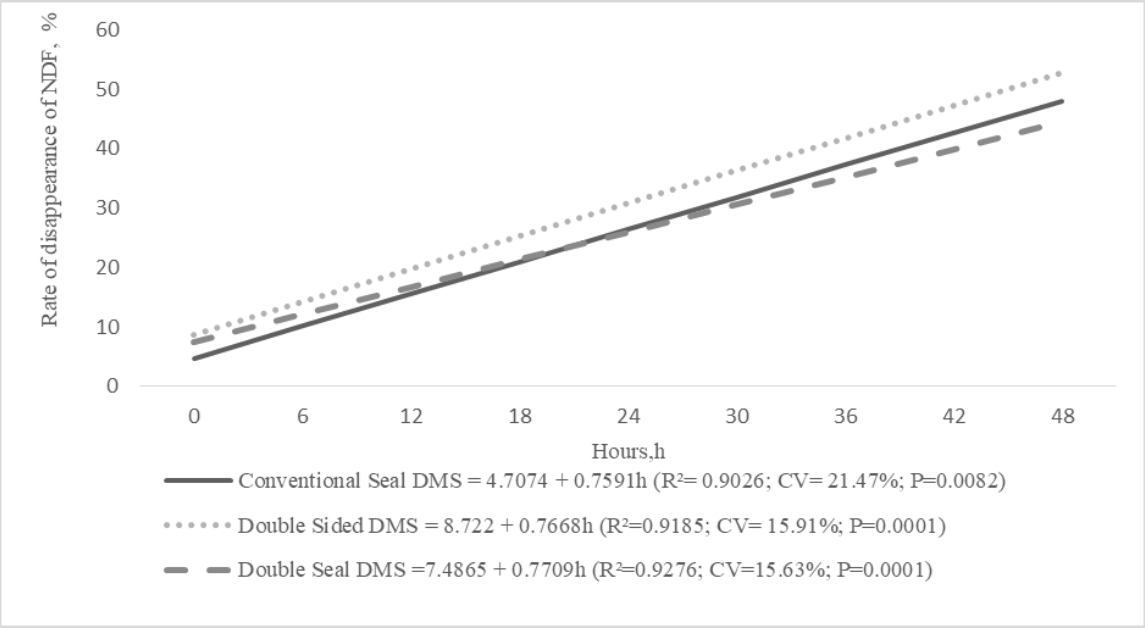

Figure 2. In situ ruminal disappearance rate of neutral detergent fiber of corn silage from the feed out face of trench silos with different types of sealing.

The presence of oxygen inside the silo combined with the availability of substrate stimulates the growth of yeasts that degrade non-fiber carbohydrates, causing an increase in the concentration of fiber carbohydrates and/or indigestible components due to the concentration effect, these carbohydrates being less digestible (Rooke & Hatfield, 2003). The better use of the fiber portion of the silage has a positive correlation with responses in increasing milk and meat production (Barlow *et al*., 2012). The digestibility of corn silages is extremely important, as foods with better digestibility values allow greater intake of dry matter, better use of the food supplied, allowing productive increases and collaborating to dilute production costs (Ferraretto and Shaver, 2015; Neumann *et al*., 2017).

CONCLUSIONS

The double-sided seal with a thickness of 200µm and the double seal made of double-sided polyethylene overlying a polyamide film showed similar results and their use is recommended for sealing the feed out face of trench silos. It is not recommended to use double-sided polyethylene seal with less than 200µm thick to preserve corn silage from the feed out face of trench silos.

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