Effects of the application of molasses and whey on the organoleptic and nutritional quality of the silage of two varieties of corn *Zea mays l*

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Abstract

The investigation was carried out in the District of Carayao, Department of Caaguazú during the months of September 2021 to February 2022; The objective of the work was to evaluate the effects of the application of the additives, molasses and whey on the organoleptic and nutritional quality of the silage of two varieties of corn. The variables measured were: organoleptic characteristics (color, odor and texture), fermentation indicator (pH), bromatological variables (dry matter, crude protein, acid detergent fiber, neutral detergent fiber, starch, in vitro dry matter digestibility, metabolizable energy). The research was proposed under an AxB factorial design with 10 treatments and three repetitions, where the factors were: A; corn varieties (Karape Pytã and DKB290PRO3), factor B; additives (no additives, molasses at 3%, whey at 3%, mixtures of molasses and whey in combinations of 2:1 and 3:1 at 3%). Each experimental unit consisted of a PVC microsilo 60 cm high and 100 mm in diameter. ANAVA statistical analysis and the Scott and Knott test were performed to compare means. Where the following results were obtained: In factor A, the variety DKB290PRO3 obtained the best results in the variables pH, MS, PB, FDA, NDF, Starch, % DIVMS, and ME. In factor B, the treatments without additives obtained the best results in the variables pH, FDA, %DIVMS, and Starch, for the MS and NDF variable the addition of molasses + whey 2.:1 at 3% and molasses at 3 % respectively yielded the best results. Interactions between the factors were observed in the variables EM, FDA, %DIVMS and Starch in the other variables, there were no significant statistical differences. In the organoleptic characteristics, it was observed that the inclusion of molasses at 3% in the corn silage improves the organoleptic characteristics.

Keywords: forage, conservation, quality

Introduction

Silage is a forage conservation method, easy to use and low cost, it allows forage conservation through an anaerobic fermentation process, this method is an alternative to replace the low pasture production in the country in periods of scarcity and The raw material used is the green material of the forage resources produced in the spring and summer periods, which are the times of greatest production

Among the forages, corn is one of the forage resources mostly used in silage, due to its good nutritional quality, low buffering power that allows the pH to drop rapidly, and high productions of green forage in tons/ha. In addition, it provides high energy concentration and an acceptable level of protein.

The use of additives within silage is an alternative to optimize the fermentation process and increase nutritional values or improve organoleptic characteristics. The additives used in this work were molasses and whey, seeking to improve the nutritional and organoleptic quality of corn silage.

The objective of the research was to evaluate the effects of the application of molasses and whey on the organoleptic and nutritional quality of the silage of two corn varieties**.**

Methodology

The investigation was carried out on the property of Mr. Eugenio Amarilla located in Colonia Teniente Morales, District of Carayaó, Department of Caaguazú, Eastern Region of Paraguay, 30 km from the City of Coronel Oviedo. The geographical coordinates are 25°16'26" S 56°16'15"W, we worked for 6 months between the months of September 2021 to February 2022. The research consisted of an infinite population, where the selection of The samples were expressly constituted by microsilos of 2.6 kg capacity, composed of two varieties of Zea mays maize (Karape pytã and the hybrid DKB290PRO3).

The measurement variables were; Organoleptic characteristics: Color, Smell, Texture. Fermentation indicator: pH. Nutritional quality variables: dry matter, crude protein, acid detergent fiber, neutral detergent fiber, starch, in vitro digestibility of dry matter, and metabolizable energy

The experimental design adopted was factorial AxB where A indicates two varieties of corn (Karape pytã and DKB290PR03) and B indicates five additives, (No additives, 3% molasses, 3% whey, Molasses + Milk whey = 2: 1 to 3%, Molasses + Whey = 3:1 to 3%) with 10 treatments and three repetitions, totaling 30 experimental units (EU). Each experimental unit consisted of 2.6 kg capacity microsilos made up of PVC pipes 100 mm in diameter by 60 cm in length.

ANAVA analysis of variance was performed and the results that were significant, the comparison of means

was performed through the Scott and Knott test at 5% probability of error using the Infostat statistical package. In the cases in which interactions were found, the interaction graph with Minitab v.13 was applied. for your interpretation.

Results and Discussion

Organoleptic characteristics

Table 1. Evaluation of the organoleptic characteristics of the silage of two corn varieties with the application of different types of additives

Treatments	Color	Smell	Clasification
A_1B_1	Olive-Green	Pleasant, with a slight vinegar smell	Okay
A_1B_2	Dark yellow	To honey or sweetened with ripe fruit	Excellent
A_1B_3	Olive-Green	Strong, acidic with a vinegar smell	Okay
A_1B_4	Dark-yellow	Pleasant, with a slight vinegar smell	Okay
A_1B_5	Dark-yellow	Pleasant, with a slight vinegar smell	Okay
A_2B_1	Yellowish green	Pleasant, with a slight vinegar smell	Okay
A_2B_2	Dark-yellow	To honey or sweetened with ripe fruit	Excellent
A_2B_3	Olive-Green	Pleasant, with a slight vinegar smell	Okay
A_2B_4	Dark-yellow	Pleasant, with a slight vinegar smell	Okay
A_2B_5	Dark yellow	Pleasant, with a slight vinegar smell	Okay

In Table 1, the organoleptic characteristics of the corn silage produced by effects of the treatments are observed, based on the organoleptic quality indicators proposed by Chaverra and Bernal (2000).

The silages obtained from both maize varieties generally presented good characteristics; good color and smell and excellent texture; except the treatments with 3% molasses that presented excellent smell, color and texture

The smell of the materials on average was Good, that is, a product with a pleasant smell with a slight smell of vinegar and which is consistent with the good conditions of the silage.

The color mostly presented Excellent characteristics according to the parameters used, since no materials with dark brown, almost black or black coloration were found. The texture reached the qualification of Excellent, that is, a silage that perfectly maintained its continuous contours

These characteristics fully coincide with an investigation carried out by Saldaña Benavides (2018), where it was observed that with the addition of molasses and whey in chala corn microsilos, all the treatments presented Good to Excellent characteristics

Fermentation indicator (pH)

The results of the means indicated that the pH variable in factor (A) presented significant differences, being A2 (DKB290PRO3) the one that obtained the best results with a mean of 4.26; likewise, in factor (B) there were significant differences where B1 and B3 (Without additives and 3% whey) yielded the best results with an average of 4.21 and 4.27 respectively, these values are within the limits indicative ranges of good fermentation in silages

Table 2. Comparison of means with the Scott and Knott test for the variable (pH)

Factor A (Varieties)	**Stockings**	**Classification**
A_2 DKB290PRO3	4,26	A
A_1 Karape Pytã	4,34	B
P-valor	0,0094*	
Factor B (Aditivos)	**Stockings**	**Classification**
B_1 Withous Additives	4,21	A
B_3 Serum al 3%	4,27	A
B_2 Molasses al 3%	4,31	B
B_4 Molasses + Serum= 2:1 al 3%	4,33	B
B_5 Molasses + Serum = 3:1 al 3%	4,4	B
P-valor	0,0032*	
CV (%)	1,74	

According to Molina and Ruiz, cited by Montesdeoca (2017), corn and sorghum silages contain a sufficient amount of soluble sugars and normally do not require additives to achieve good fermentation. Data that coincides with this investigation, because the treatments that did not receive any additive were the ones that presented the best results

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The data obtained in this research differ from the results obtained by Salas et al (2014), who demonstrated that the addition of molasses and whey at 2% in corn silage registers acidic pH in all treatments, obtaining better results with respect to the control treatment with means of 3.76; 3.59 and 4.08 respectively. This is because whey is a material with high amounts of lactose in its composition that promotes the production of lactic acid bacteria by being a substrate for their proliferation.

In addition, molasses is considered an energetic additive since it is a rich source of soluble carbohydrates that do not crystallize to form sucrose, which favors the development of microorganisms desired for good fermentation

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Nutritional quality variables

Dry matter, Crude Protein, Metabolizable Energy, Acid Detergent Fiber, Neutral Detergent Fiber, % In Vitro Digestibility of Dry Matter and Starch

According to analysis of variance and comparison of means with the Scott and Knott test, the following results are observed for the nutritional quality variables.

Table 3 shows the results of the means for the nutritional quality variables, for the factor (A) varieties, differences were observed in the variables DM, CP, NDF and Starch, in all cases (A2) DKB290PRO3 obtained the better results, for the variables EM, FDA and % IVDMS there were no statistically significant differences. In a study carried out by Macay (2015), he reports an average protein in the maize hybrids used in his research of 9.6 %. Data that coincide with this research, and that demonstrate the superior quality of the hybrids with respect to conventional varieties

In addition, the results obtained in this investigation were superior to those obtained in an investigation carried out by Ibarra Daniel et al. (2014) in which they compared 4 hybrid maize varieties, where they obtained averages between 62.7 to 63.5% of DIVMS. Data that demonstrates the high digestibility of the varieties used in the present investigation

In Factor (B) additives, it is observed that there were no statistical differences in the variables MS and CP where no increases in the percentages were observed with the addition of additives. In the variables EM, FDA, NDF, %IVDMS and Starch there were significant differences, the similarity is observed between the treatments (B1 and B2) without additives and 3% molasses with superior results to the other treatments

The data obtained in this investigation coincide with a study carried out by Granados Marín (2010), which determined that the application of additives (mixtures of molasses and whey) to silages of Pasto Estrella Cynodon nlemfluensis, did not present significant increases in the values of CP, since these are considered energy additives and the inclusion of carbohydrates does not affect the Crude Protein content

Likewise, Montesdeoca (2017), has concluded in his research that molasses stimulates the decrease of NDF in silage. The effect of the mixtures of

molasses and whey on the NDF are less than the treatment with only molasses, however, the NDF showed a tendency to decrease compared to the non-application of carbohydrates. In relation to the FDA, it concludes that molasses reduces the FDA content (38.59), with respect to the treatment without additives (39.08). Data that coincide with the results obtained in this investigation

Table 3. Comparison of means with the Scott and Knott test for the Nutritional Quality variables

	M.S.	***P.B.***	***E.M.***	***F.D.A***	***F.D.N***	***%DIVMS***	***Starch***
FACTOR A (Varieties)	***(%)***	***(%)***	***(Mcal/ kg/MS)***	***(%)***	***(%)***	***(%)***	***(%)***
A_2DKB290 PRO3	31,54 A	9,59 A	2,46 A	29,01 A	51,58 A	66,29 A	16,58 A
A_1Karape Pytã	27,66 B	8,01 B	2,43 A	29,91 A	53,62 B	65,58 A	15,03 B
P-valor	0,0001*	<0,0001*	0,0425ns	0,0719ns	0,0135*	0,4302ns	0,0044*
FACTOR B (Additives)	***(%)***	***(%)***	***(Mcal/ kg/MS)***	***(%)***	***(%)***	***(%)***	***(%)***
B_1 Sin Additives	30,1 A	9,4 A	2,48 A	28,33 A	51,34 A	66,79 A	17,2 A
B_2 Molasses al 3%	29,28 A	8,62 A	2,48 A	28,43 A	50,25 A	66,75 A	17,17 A
B_3 Serum al 3%	28,84 A	8,8 A	2,44 B	29,88 B	53,57 B	65,62 B	15,51 A
B_4 Molasses + Suero= 2:1 al 3%	30,14 A	8,46 A	2,45 B	29,6 B	52,93 B	65,84 B	15,82 A
B_5 Molasses + Suero= 3:1 al 3%	29,63 A	8,71 A	2,4 B	31,06 B	54,9 B	64,7 B	13,34 B
P-valor	0,817 ns	0,0845 ns	0,0069*	0,0099*	0,0078*	0,0073*	0,0004*
CV %	7,37	6,47	1,48	4,38	3,87	1,48	8,37

Effects of the interaction of factors on the variables Metabolizable Energy, Acid Detergent Fiber, % In Vitro Digestibility of Dry Matter and Starch.

The ANAVA table indicates that there was an interaction between the factors for the variables ME, FDA, %IVDMS and Starch.

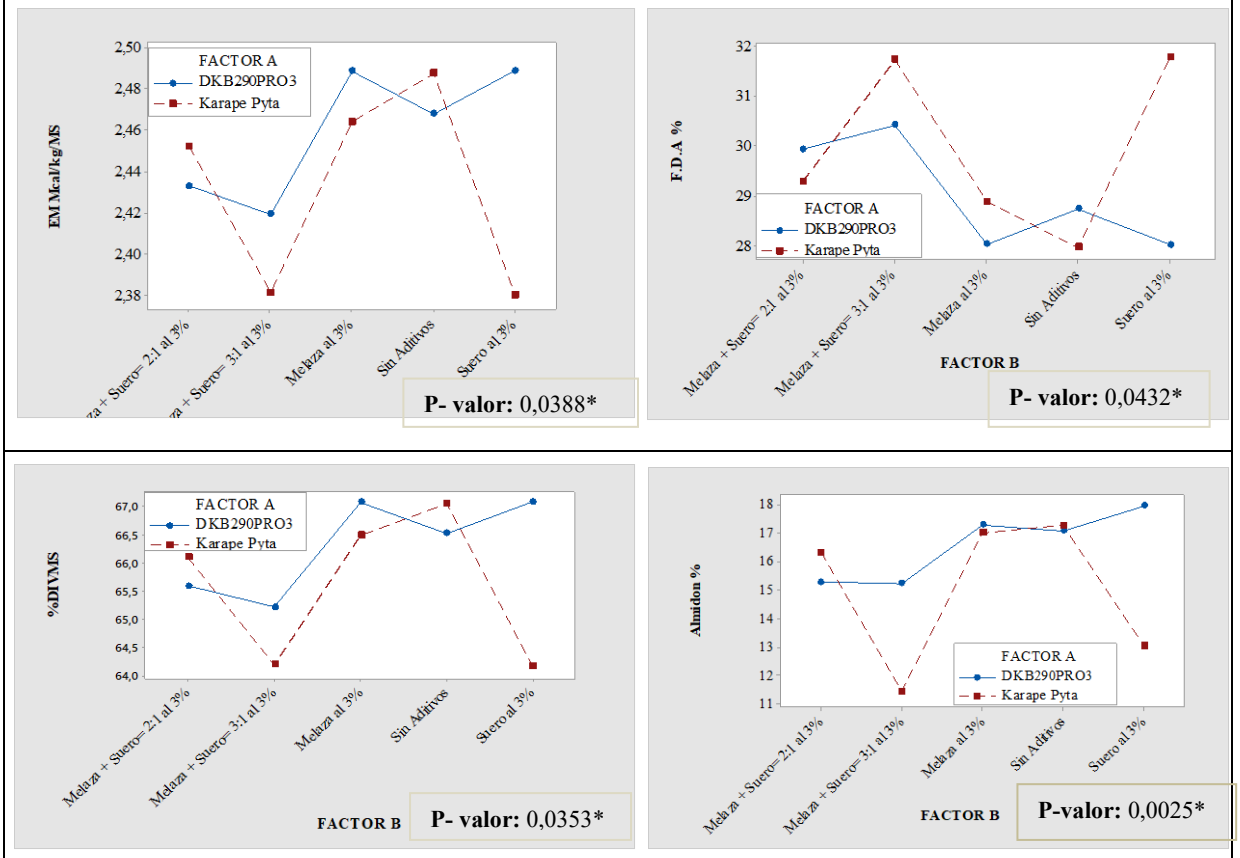

Figure 1. Interaction between the factors for the variable Metabolizable Energy, Acid Detergent Fiber, % In Vitro Digestibility of Dry Matter and Starch

The figure shows the interaction of the factors varieties and additives on the variables EM, FDA, %IVDMS and Starch where the treatments DKB290PRO3 with 3% whey, DKB290PRO3 with 3% molasses and Karape pytã without additives obtained the results on the other combinations in the variables in which there were interactions.

In a study carried out by Salas et al (2014), they found that in the treatments where whey was applied to corn silages, they obtained higher averages (2.24 Mcal/KgDM), with respect to the control treatment (2.18 Mcal/ KgDM), and to the treatment where molasses (2.05 Mcal/KgDM) was applied.

These results differ slightly with the results obtained in this investigation, although the treatments applied with whey obtained good results, they were not superior to the control treatment and the treatment with molasses, perhaps because the silages were made under optimal conditions, taking care of the maximum conditions to obtain a good product, such as: chopped size, high content of soluble carbohydrates (grains) and adequate compaction.

On the other hand, the results obtained in this investigation coincide with a study carried out by Pineda et al. (2016) where it shows that Cynodon nlemfluensis star grass silages mixed with molasses presented lower values in NDF and FDA, with respect to the other treatments mixed with other types of additives

Conclusions

The addition of 3% molasses in corn silage improves the organoleptic characteristics. No effect of factor (A) varieties was observed.

The corn varieties influence the pH values for the silage, the additives have no effect on the pH, in the same way that there were no interactions.

For the variables of nutritional quality, dry matter, crude protein, acid detergent fiber, neutral detergent fiber, starch, % in vitro digestibility of dry matter, and metabolizable energy, the hybrid variety DKB290PRO3 presented the best results, in the factor (B), the treatments without additives obtained better results in the variables crude protein, acid detergent fiber, starch, % in vitro digestibility of dry matter, and metabolizable energy, but not in the variables dry matter and neutral detergent fiber, where the application of molasses + whey=2:1 at 3% and molasses at 3% respectively yielded the best results

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