

PREDICTION OF THE NUTRITIONAL VALUE AND IN VITRO DIGESTIBILITY OF FORAGE PRODUCED BY DIFFERENT MAIZE HYBRIDS

Lucas Rafael Santos Molina¹  ; Érica de Oliveira Araújo²  ; Nivaldo Muniz de Sousa¹  ; Jhonathann Willian Furquin da Silva³  ; Túlio Orloski de Castro Pereira¹  ; Eduardo Miranda Ferreira Silva¹  ; Gabriel Monteiro Paulino¹ 

*Corresponding author: erica.araujo@embrapa.br

¹ Instituto Federal de Educação, Ciência e Tecnologia de Rondônia, Colorado do Oeste, RO, Brasil.

² Embrapa, Campo Experimental de Vilhena, Vilhena, RO, Brasil.

³ Helix Sementes e Biotecnologia Ltda., Rio Claro, SP, Brasil.

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ABSTRACT – Estimating the nutritional value and in-vitro digestibility of forage is important both to support adequate feeding management of forage based and to guide genetic improvement programs. In this context, the present study aimed to evaluate the yield and estimate the nutritional composition and in-vitro digestibility of the forage produced by different maize hybrids. The experiment was conducted under field conditions during the 2023/2024 crop season in the municipality of Colorado do Oeste, RO, Brazil. The experimental design was randomized blocks, composed of twelve maize genotypes (HLX2277 CO, HLX2162 CO, FS620PWU CO, B2433PW CO, P3016VYHR CO, HLX2124 PRO3, HLX2104 PRO3, HL2065 PRO3, SHS7990 PRO3, SHS7970 PRO3, BM3069 PRO3, BM3066 PRO3) and three replicates. At the phenological stage of grains with a farinaceous aspect, the whole plant was harvested and the dry mass was chopped, crushed and sent for bromatological analysis. At physiological maturity, ten representative ears were sampled per plot to determine the production components. The hybrid HLX2162 CO stands out in plant height, kernel rows per ear, kernels per row, and grain yield. Additionally, it exhibits the highest levels of water-soluble carbohydrates and higher *in vitro* NDF digestibility in the forage, making it recommended for the evaluated edaphoclimatic conditions. The forage from the different corn hybrids shows high coefficients of *in vitro* dry matter digestibility and NDF digestibility, with average digestible and metabolizable energy contents of 3.10 Mcal.kg⁻¹ and 2.68 Mcal.kg⁻¹, respectively, corrected to 90.17% dry matter.

Keywords: yield, bromatology, NIRS, western Amazon.

Brazil's territorial extension and edaphoclimatic conditions are fundamental elements for the country to have a relevant grain production (Rego et al., 2023). Brazil stands out among the largest exporters and producers of food, being the third largest producer of maize in the world (Estados Unidos, 2025). For the 2024/2025 season, the national estimate of the area planted with maize was 21.8 million hectares with a production of 139 million tons (Conab, 2025). Maize is the prominent forage for silage production both in Brazil (Bernardes & Rêgo, 2014) and in other countries (Ferraretto & Shaver, 2015), for having a high content of soluble carbohydrates and, when well managed, can offer high dry matter production per hectare and high nutritional value (Seglar & Shaver, 2014; Silva et al., 2018).

In the current context, with the large fluctuations in the cost of concentrated feed, it is essential to characterize the quality of forage and roughage through reliable techniques to reduce production costs. Near-infrared spectroscopy has been used as a method to evaluate the bromatological composition of various feeds used in animal nutrition (Lobos et al., 2013; Feng et al., 2023) and stands out as a fast, non-destructive, low-cost chemical analysis that allows the use of a large number of samples and with different materials (Pereira, 2024).

In this context, estimating the nutritional value and in-vitro digestibility of forage is important both to support adequate feeding management of forage-based diets and to guide genetic

improvement and plant selection programs, allowing greater precision in the prediction of animal performance and in the evaluation of forage or silage quality. According to Horst et al. (2020), the nutritional value and quality of silage are associated with the quality and participation of each structural component of the plant, as well as the digestibility of the vegetative portion. Araújo et al. (2021) and Araújo et al. (2024b) found that the nutritional quality of forage and silage was correlated with the structural composition of the forage plant. Hybrid choice has a direct influence on the quality of the resulting silage (Moraes et al., 2013), as each hybrid has a different agronomic and nutritional behavior (Silva et al., 2018).

Therefore, considering the large amount of genetic material available in the market, the selection of maize genotypes based on their forage nutritional composition and the use of hybrids adapted to regional edaphoclimatic conditions enhance the productive and nutritional performance of the crop, compared to non-selected and/or non-adapted genotypes. Thus, the present study aimed to evaluate the yield and estimate the nutritional composition and in-vitro digestibility of the forage produced by different maize hybrids, with a view to deepening the technological process, maximizing the efficiency and profitability of forage production in the western Amazon.

Materials and Methods

The experiment was conducted under field

conditions from October 2023 to February 2024, in the experimental area of the Federal Institute of Rondonia, in the municipality of Colorado do Oeste, RO, Brazil, whose geographic coordinates are 13° 06' S and 60° 29' W, with an average altitude of 407 meters (Figure 1). The climate of the region, according to the Köppen-Geiger classification, is Aw type (tropical climate with dry winter) (Beck et al., 2018).

Average temperature and rainfall data (Figure 2) during the experiment were obtained from the FieldClimate (Pessl Instruments, 2024) data base, and chemical characterization of the soil in the 0-20 cm layer in samples collected prior to the experiment showed the following results: pH (H₂O) = 6.5; OM = 17.8 gkg⁻¹; P = 14.4 mg dm⁻³; K = 45.2 mg dm⁻³;

Ca = 7.8 cmol_c dm⁻³; Mg = 0.7 cmol_c dm⁻³; Al = 0.0 cmol_c dm⁻³; H+Al = 2.1 cmol_c dm⁻³; SB = 8.6 cmol_c dm⁻³; CEC = 10.7 cmol_c dm⁻³; and V = 80%. Soil chemical analysis was performed at the Soil Laboratory of the Federal Institute of Rondônia, Campus Colorado do Oeste, certified by the Quality Control Program for Fertility Laboratories and accredited by the Brazilian Agricultural Research Corporation (Embrapa). The soil of the experimental area is classified as Argissolo Vermelho Amarelo Eutrófico (PVAe) (Oliveira et al., 2019).

The experimental design was randomized blocks, composed of twelve maize genotypes (HLX2277 CO, HLX2162 CO, FS620PWU CO, B2433PW CO, P3016VYHR CO, HLX2124 PRO3, HLX2104 PRO3, HL2065M PRO3, SHS7990 PRO3, SHS7970 PRO3, BM3069

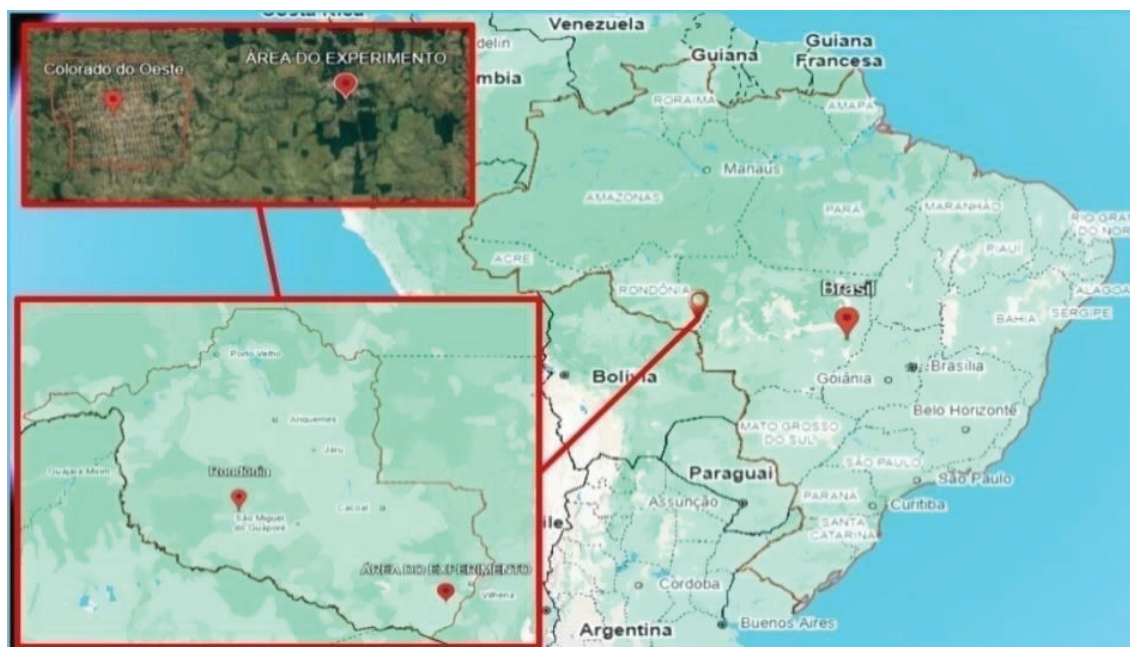


Figure 1. Experimental location.

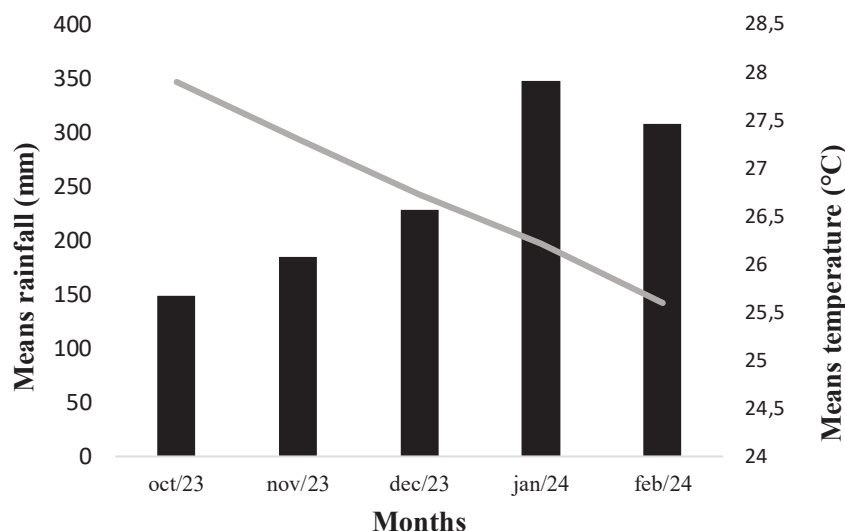


Figure 2. Average data of temperature and rainfall during the experiment.

Source: Pessl Instruments (2024).

PRO3, BM3066 PRO3) and three replicates, carried out in the furrow at a dose of 300 kg.ha⁻¹, totaling 36 experimental units. Agronomic characteristics and purposes of the different maize hybrids are presented in Table 1.

The trial began with soil preparation by harrowing up to 15 cm deep. Planting and fertilization furrows were mechanically opened at 5 cm depth and according to the spacing. The different maize hybrids were sown on November 14, 2023, by means of manual sowing using a handheld seeder, at a spacing of 0.80 m between rows and a population density of 75,000 plants ha⁻¹. Each experimental unit was 5 m wide and 5 m long, considering the central rows as the usable area of each plot, excluding 0.50 m from each end of the plot, for data collection observations (Figure 3).

At the time of sowing, fertilization was

carried out with the formulation 4-30-10 (N-P₂O₅-K₂O), corresponding to 12 kg of N, 90 kg of P₂O₅ and 30 kg of K₂O. Topdressing nitrogen fertilization, at a dose of 200 kg.ha⁻¹ of N, was applied to the total area of the plot, using urea (45%) as the source, divided into two equal portions and applied at the phenological stages V4 and V6, corresponding to four and six fully expanded leaves. 50 kg.ha⁻¹ of K, using potassium chloride (60%) as the source, 750 mL.ha⁻¹ of the fungicide Opera and 350 mL.ha⁻¹ of the Engeo Pleno insecticide were applied at the phenological stages V4 and V6. The other cultural practices were carried out as recommended for the crop.

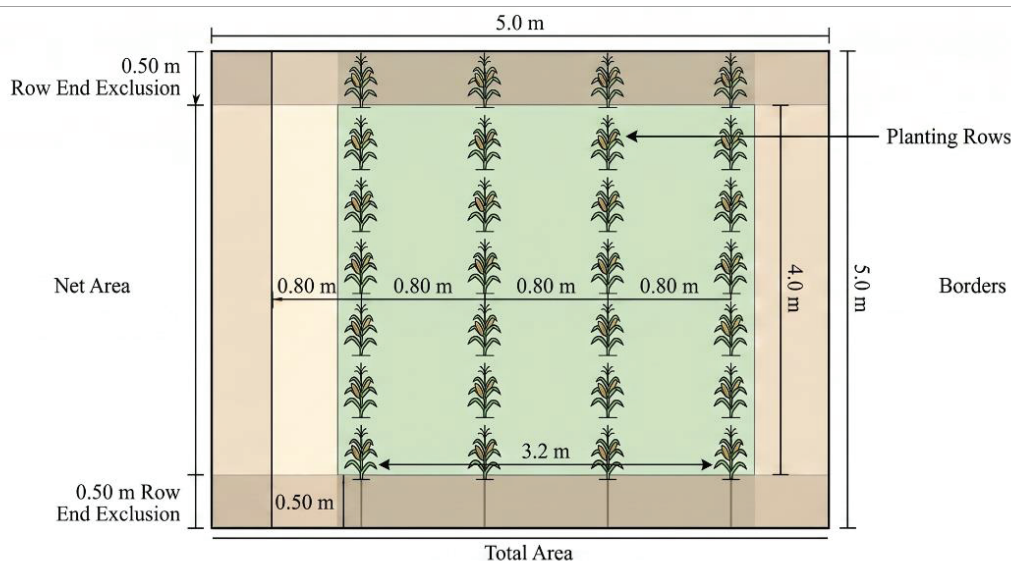
At the phenological stage R5, when the grains showed a texture with a farinaceous

aspect and dry matter content between 30 and

Table 1. Agronomic characteristics and purposes of different maize hybrids.

Hybrids	Purpose	Cycle	Architecture
HLX2277 CO	Silage	Early	Semi-erect
HLX2162 CO	Silage	Early	Decumbent
FS620PWU CO	Grain/Silage	Early	Normal
B2433PW CO	Grain/Silage	Early	Normal
P3016VYHR CO	Grain/Silage	Early	Normal
HLX2124 PRO3	Grain/Silage	Super early	Semi-erect
HLX2104 PRO3	Grain/Silage	Early	Decumbent
HL2065 PRO3	Grain/Silage	Early	Decumbent
SHS7990 PRO3	Grain	Early	Normal
SHS7970 PRO3	Grain/Silage	Early	Semi-erect
BM3069 PRO3	Silage	Early	Semi-erect
BM3066 PRO3	Silage	Early	Semi-erect

*CO: conventional. *PRO3- material has high yield, stability, good leaf and stem health, and tolerance to maize white spot and Bipolaris leaf spot.



Technical Specifications Summary

Parameter	Measurement	Parameter	Measurement
Total Plot Dimensions	5.0 m x 5.0 m	Number of Net Rows	4
Inter-row Spacing	0.80 m	Linear Plant Density	6 plants/m
Number of Total Rows	6	Total Plant Population	75,000 plants/ha
Number of Net Rows	4	Net Area Dimensions	3.2 m x 4.0 m
		Row End Exclusion	0.50 m

Figure 3. Technical layout of the experimental unit used for the different corn hybrids.
Prepared by: Notebook LM.

35%, whole plants were harvested from a strip of 3 linear meters selected within the central rows, by cutting at 0.20 m height from the soil level. To determine dry matter content, plants from the usable area plot were harvested and chopped using a manual forage chopper. A 500 g sample was then taken and dried in a forced-air oven at 65 °C for 72 hours. After this period, the samples were removed from the oven and weighed on a precision balance. Yield (in t.ha⁻¹) was determined based on the hybrid's dry matter percentage, calculated from the difference between fresh and dry weights. Subsequently, the remaining material from each experimental unit was ground in a Wiley knife mil, and sent

for bromatological analysis in a Near Infrared Reflectance Spectrometer, model Spectra Star 2600 XT (Unity Scientific®) in duplicates. The parameters analyzed were dry matter, crude protein, neutral detergent fiber, acid detergent fiber, % lignin in neutral detergent fiber, lignin, starch, ether extract, mineral matter, non-fibrous carbohydrate, water-soluble carbohydrate, total digestible nutrients, soluble protein, rumen-degradable protein, rumen-undegradable protein, dry matter and neutral detergent fiber digestibility profile, digestible energy and metabolizable energy.

Plants were evaluated for plant height and ear insertion height. Plant height was measured

from the point at which the cut was made to the ligule of the last expanded leaf from the top (Ritchie et al., 1993), while ear insertion height was measured from the point at which the cut was made to the node where the ear was inserted. At physiological maturity (R6) and to determine the production components, ten representative ears per plot were sampled and evaluated for the number of rows, number of grains per row and number of grains per ear, and grain yield was estimated. The number of grain rows, number of grains per row and number of grains per ear were obtained by counting, while the grain yield estimate was obtained after threshing all the ears from the usable area of each plot, weighing the grains and correcting the values to 13% moisture content.

After all the analyses, the data were subjected to tests to check for the assumptions of normality and homogeneity. When these assumptions were met, they were subjected to analysis of variance by the F test, and when the parameters showed a significant difference, the means were grouped by the Tukey test, at 5% probability level, using the statistical program Sisvar (Ferreira, 2019).

Results and Discussion

In the agronomic evaluation, the results revealed a significant difference ($p < 0.05$) between the maize hybrids for plant height, ear insertion height, number of rows, number of grains per row, number of grains per ear and grain yield (Table 2), while in the bromatological composition of the forage, significant differences

($p < 0.05$) were found only for the parameters water-soluble carbohydrate and *in-vitro* NDF digestibility at 24h (Table 4 and Table 5). Experimental precision was adequate, since the coefficients of variation were between 1.52% and 25.22%, below the limits defined for experiments with maize (Fritsche-Neto et al., 2012).

The hybrids BM3069 PRO3, P3016VYHR CO and HLX2162 CO showed the highest plant heights, 3.13, 3.12 and 3.10 m, respectively, not differing statistically from the hybrids HLX2124 PRO3, HLX2104 PRO3 and HLX2277 CO. On the other hand, the hybrids B2433PW CO, BM3066 PRO3, HL2065 PRO3 and FS620PWU CO had the lowest plant heights, with an average of 2.72 m (Table 2). The hybrid HLX2162 CO recorded the highest ear insertion height (1.42 m) and differed statistically from B2433PW CO, BM3066 PRO3, HL2065 PRO3, FS620PWU CO and SHS7970 PRO3, which had the lowest ear insertion height (Table 2).

Plant height and first ear insertion height are important quantitative characteristics, as they can be linked to the hybrid's tolerance to lodging (Neumann et al., 2024). The average values of plant height and ear insertion height observed in the trial were 2.93 m and 1.20 m, respectively, and can be considered adequate, since many ears are inserted around the midpoint of the plant, which makes the genotypes less susceptible to lodging. In addition, ear insertion height facilitates mechanized harvesting and can significantly improve the quality of the material for silage, as it influences the proportion between

Table 2. Dry matter (DM), plant height (PH), ear insertion height (EIH), number of grain rows (NGR), number of grains per row (NGPR), number of grains per ear (NGE) and grain yield estimate (GY) of different maize hybrids grown in the 2023/2024 season.

HYBRIDS	DM	PH	EIH	NGR	NGPR	NGE	GY
	t ha ⁻¹	m.....	un.....				kg ha ⁻¹
BM3069 PRO3	26.04 ab	3.13 a	1.24 ab	14.48 c	31.17 ab	451.40 bc	6,143.26 b
BM3066 PRO3	26.42 a	2.68 c	1.17 bc	14.91 c	31.01 ab	462.55 abc	5,559.11 b
HLX2124 PRO3	25.90 ab	3.07 ab	1.31 ab	15.23 abc	28.95 ab	440.50 bc	6,647.19 ab
HLX2104 PRO3	23.44 b	3.06 ab	1.32 ab	15.70 abc	28.48 b	446.68 bc	6,973.72 ab
HL2065M PRO3	25.53 ab	2.73 c	1.18 bc	14.98 c	28.87 ab	432.53 c	6,309.32 b
SHS7990 PRO3	25.97 ab	2.89 bc	1.24 ab	15.11 bc	31.33 ab	474.02 abc	6,910.00 ab
SHS7970 PRO3	25.97 ab	2.84 bc	1.17 bc	15.49 abc	30.52 ab	472.32 abc	6,196.29 b
HLX2162 CO	24.21 ab	3.10 a	1.42 a	16.15 abc	34.86 a	564.03 a	8,756.73 a
HLX2277 CO	23.47 ab	3.07 ab	1.26 ab	16.85 a	32.56 ab	548.40 ab	7,082.00 ab
FS620PWU CO	25.73 ab	2.80 c	0.98 c	16.71 ab	29.36 ab	491.18 abc	6,797.75 ab
B2433PW CO	25.01 ab	2.67 c	0.99 c	16.87 a	27.63 b	465.70 abc	5,621.75 b
P3016VYHR CO	26.04 ab	3.12 a	1.27 ab	16.69 ab	31.91 ab	532.58 abc	7,243.59 ab
Means	25.31	2.93	1.20	15.76	30.55	481.82	6,686.72
p-value	0.00*	0.00*	0.00*	0.00*	0.01*	0.00*	0.00*
CV (%)	3.96	2.94	6.17	3.65	6.87	7.74	11.57
dms-Tukey 5%	2.97	0.26	0.22	1.71	6.24	110.88	2300.35

*Means followed by equal letters in the columns do not differ from each other by Tukey test at 5% probability level. ^{ns}- not significant and * significant by Tukey test at 5% probability level. CV: coefficient of variation. p-value: probability of the analysis of variance F test. dms: Least significant difference at 5% probability level by Tukey test.

grains (more energetic) and stem (more fibrous) in the harvested material. The results obtained corroborate with those found by Araújo et al. (2026), Araújo et al. (2024a), Brito et al. (2024) and Fernandes et al. (2024) in evaluations of the agronomic performance of different maize hybrids under field conditions in the southern region of Rondônia and Pará.

The highest green mass yield per hectare was obtained by hybrid BM3066 (26.42 t.ha⁻¹), which differed statistically from the other materials, producing on average 12.71% more than the lowest-yielding hybrid (HLX2104 PRO3) (Table 2). As far as the production components is concerned, the hybrids HLX2277 CO and B2433PW CO produced ears with the highest number of grain rows, 16.85 and 16.87, respectively. On the other hand, the hybrids BM3069 PRO3, BM3066 PRO3 and HL2065M PRO3 had the lowest number of rows, with values of 14.48, 14.91 and 14.96, respectively (Table 2). The highest number of grains per row was observed in the hybrid HLX2162 CO (34.84 grains), differing statistically only from HLX2104 PRO3 and B2433PW CO, which had the lowest production of grains per row (Table 2). The highest and lowest production of grains per ear was found in the hybrids HLX2162 CO and HL2065M PRO3, respectively, which makes it possible to infer a positive association with grain yield per hectare (Table 2).

In general, the maize grain yield obtained in the experiment was significantly high, reaching 6,686.72 kg ha⁻¹. This result represents a value 15.60% higher than the national average for the

first-season cultivation in 2023/2024, which was 5,784.00 kg ha⁻¹ (Conab, 2025). Similar results of high yield were reported by Araújo et al. (2024b), who evaluated the yield of eight transgenic genotypes of dual-purpose maize in the state of Rondônia and obtained an average of 9,760.00 kg ha⁻¹. According to Simão et al. (2018), the maximum expression of the production potential in the cultivation of maize grains depends intrinsically on genetic and edaphoclimatic factors. Sowing maize in the first season usually exposes the crop to better weather conditions during growth and vegetative development. This allows plants to accumulate more carbohydrates between pre and post-tasseling, thereby increasing grain mass and favoring the other production components, which partly justifies the grain yield found in this study (Souza et al., 2026).

For the bromatological composition of the forage, although there was no statistical difference ($p>0.05$) between the maize hybrids evaluated, the average concentration of crude protein (CP) was 8.51%, considered adequate to meet the nutritional requirement of the rumen microbiota (Table 3). Similarly, the average level of ether extract (EE) in forage was 3.12% (Table 3), falling within the range of values observed in the literature, which range from 2.1 to 3.8% (Khan et al., 2012; Tres et al., 2014) and which are considered suitable for good whole-plant maize silage. Similar results were reported by Santos et al. (2023), who obtained an average CP of 8.23% among the maize genotypes evaluated,

with a variation between 9.65% (maximum) and 7.31% (minimum), by Araújo et al. (2024b), who analyzed CP concentration in the forage from seven maize hybrids and found an average of 8.36%, and by Tres et al. (2014), who evaluated the chemical-bromatological characteristics of thirty maize genotypes and found CP contents ranging from 6.5 to 8.4%.

Regarding the concentration of neutral detergent fiber (NDF) and acid detergent fiber (ADF), the mean values in dry matter were 45.11 and 26.30%, respectively, which are indicative of feed intake and digestibility (Table 3). These results are considered low and suggest a lower percentage of lignin (2.82%), indicating a higher proportion of grains in the forage. Consequently, this composition gives the forage adequate percentages of digestible energy ($3.10 \text{ Mcal.kg}^{-1}$) and metabolizable energy ($2.68 \text{ Mcal.kg}^{-1}$) (Table 5), coming mainly from the starch concentration (26.59%) (Table 3), and shows a small variation in the energy content among the maize hybrids. In addition, Faria et al. (2020) highlight that harvest management exerts a significant influence on the nutritional composition of forage, notably on ADF levels.

However, the selection of maize genotypes with excessively low fiber contents has generated agronomic challenges. Specifically, excessive fiber reduction has been correlated with an increase in plant susceptibility to lodging, which is a challenge particularly intensified in regions characterized by constant winds (Faria et al., 2020). Therefore, what is expected from a good

maize forage is a high energy content and quality of fiber in terms of its digestibility, in order to maximize feed intake.

The average levels of lignin and lignin in NDF were 2.82 and 6.19%, respectively (Table 3), which indicates that the forages from the different maize hybrids showed, on average, a lower participation of the fibrous fraction of the plant and a higher proportion of ears. Quantifying lignin content in forage is fundamental, given its inverse relationship with feed digestibility (Faria et al., 2020). Lignin concentration is directly influenced by plant maturity stage; advance of physiological age results in greater lignification of plant tissues. Additionally, the leaf: stem ratio is a modulating factor. It is known that the leaf fraction has intrinsically lower concentrations of acid detergent fiber and lignin when compared to the stem (Van Soest, 1994).

The average results of total digestible nutrients (TDN) observed among the different maize hybrids reached 63.38% (Table 4). This high value of TDN is indicative of good forage quality, and such nutritional performance results directly from the cutting management, which leads to a reduction in the participation of stem and leaf fractions in the harvested biomass. Consequently, there is a decrease in cell wall components and a proportional increase in grain participation, a factor that is the main determinant for increasing TDN values (Caetano et al., 2011).

Rumen-degradable protein (RDP), which represents the protein fraction available for use by the rumen microbiota, showed an average

Table 3. Dry matter (DM), crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF), lignin (LIG), percentage of lignin in NDF (%LNDF), starch (STR), ether extract (EE) and mineral matter (MM) in the forage from maize genotypes grown in the 2023/2024 season.

HYBRIDS	DM	CP	NDF	ADF	LIG	%LNDF	STR	EE	MM
-----%									
BM3069 PRO3	90.26	7.90	43.20	25.30	2.73	6.06	29.33	3.36	3.10
BM3066 PRO3	90.03	8.46	43.33	24.76	2.46	5.56	28.10	3.30	3.86
HLX2124 PRO3	90.10	7.90	46.93	27.56	3.16	6.76	24.20	2.93	3.90
HLX2104 PRO3	90.56	8.66	45.90	26.96	2.90	6.20	27.16	3.23	4.10
HL2065M PRO3	89.70	8.33	42.30	23.90	2.66	6.23	30.10	3.43	3.06
SHS7990 PRO3	89.90	9.50	43.16	24.56	2.43	5.50	28.53	3.16	4.26
SHS7970 PRO3	90.20	7.83	45.83	26.86	3.00	6.50	25.43	3.06	3.16
HLX2162 CO	89.53	9.66	44.03	24.70	2.53	5.66	25.03	3.43	4.53
HLX2277 CO	90.43	8.83	47.56	28.26	2.93	6.16	25.66	3.46	4.13
FS620PWU CO	90.56	8.96	47.50	28.53	3.03	6.40	23.20	2.86	4.16
B2433PW CO	90.46	8.06	46.73	27.80	2.93	6.26	24.73	2.50	3.96
P3016VYHR CO	90.36	8.03	44.83	26.40	3.13	6.96	27.60	2.73	3.20
Means	90.17	8.51	45.11	26.30	2.82	6.19	26.59	3.12	3.78
p-value	0.17 ^{ns}	0.12 ^{ns}	0.95 ^{ns}	0.74 ^{ns}	0.94 ^{ns}	0.82 ^{ns}	0.89 ^{ns}	0.72 ^{ns}	0.11 ^{ns}
CV (%)	1.52	9.72	11.64	12.82	25.22	16.54	20.60	20.26	13.58

*Means followed by equal letters in the columns do not differ from each other by Tukey test at 5% probability level. ^{ns}- not significant and * significant by Tukey test at 5% probability level. CV: coefficient of variation. p-value: probability of the analysis of variance F test.

value of 55.36% (Table 4). This concentration indicates a good capacity for protein synthesis in the rumen, optimizing animal performance by maximizing the availability of energy for weight gain. In contrast to RDP, rumen-undegradable protein (RUP) is not metabolized by rumen microorganisms and is, therefore, a critical parameter in protein evaluation systems for ruminants. RUP directly influences animal productivity by providing amino acids that escape the rumen and reach the intestine directly. The average RUP digestibility of the forage from the different maize hybrids evaluated was 44.63%. It is worth noting that, although there are no significant differences between the genetic materials, assessing the nutritional value of maize as forage is fundamental for feed management and the selection of plants with high dry matter production, good proportion of grains in the mass and greater digestibility of the fibrous fraction, since the quality of the forage is closely linked to the quality of its components rather than to their proportion in the dry matter (Araújo et al., 2024b).

The carbohydrates present in forages are the main source of fermentable energy in the rumen, considered crucial from a nutritional and fermentative point of view (Kung Jr et al., 2018; Wang, 2023). Thus, water-soluble carbohydrates (WSC) and proteins are the most important nutrients in forage biomass and should maintain quality during the postharvest (Ali & Tahir, 2021). It should be noted that during ensiling, under anaerobic conditions, lactic acid bacteria

convert WSC into organic acids, mainly lactic acid. The results show that the hybrids HLX2162 CO and P3016VYHR CO had the highest WSC content, despite not differing statistically from the materials HLX2124 PRO3 and SHS7970 PRO3 (Table 4).

In-vitro dry matter digestibility (IVDMD) provides information on how efficiently animals can digest and use the nutrients in the consumed diet. The higher the IVDMD values, the better the animals are able to use the nutrients available in the diet for growth, production, and other bodily functions (Bain et al., 2025). The means of in-vitro DM digestibility at 24 hours (IVDMD24h) and in-vitro DM digestibility at 48 hours (IVDMD48h) were 74.38% and 81.22%, respectively, with no significant differences ($p>0.05$) between the maize hybrids (Table 5). Conversely, Tres et al. (2014) found differences between thirty maize hybrids for IVDMD, with an average of 72.66%, and observed the highest digestibility in the group of commercial hybrids.

For the in-vitro NDF digestibility at 24 hours (IVNDFD24h) there was a significant difference ($p<0.05$) among maize hybrids, with an average value of 43.33%, while for in-vitro NDF digestibility at 48 hours (IVNDFD48h) the differences were not significant ($p>0.05$) (Table 5). The hybrid HLX2162 CO achieved the highest value of IVNDFD24h, with a statistical difference compared to BM3069 PRO3, but was similar to the other hybrids (Table 5). It is suggested that the participation of the ear in the plant can increase its digestibility (DM=90.17%

Table 4. Non-fibrous carbohydrate (NFC), water-soluble carbohydrate (WSC), total digestible nutrients (TDN), soluble protein (SP), rumen-degradable protein (RDP) and rumen-undegradable protein (RUP) in the forage from maize genotypes grown in the 2023/2024 season.

HYBRIDS	NFC	WSC	TDN	SP	RDP	RUP
	-----%-----					
BM3069 PRO3	44.33	7.43 c	64.66	33.00	52.33	47.66
BM3066 PRO3	43.10	6.96 c	64.33	34.00	56.66	43.33
HLX2124 PRO3	40.40	9.33 ab	61.33	33.66	56.66	43.33
HLX2104 PRO3	40.16	7.03 c	63.33	36.33	59.66	40.33
HL2065M PRO3	44.90	7.73 c	65.33	33.33	54.00	46.00
SHS7990 PRO3	41.96	7.96 c	65.00	31.00	52.66	47.33
SHS7970 PRO3	42.06	9.10 ab	62.33	35.33	56.33	43.66
HLX2162 CO	40.50	11.66 a	63.66	33.00	54.33	45.66
HLX2277 CO	37.96	8.90 bc	64.33	31.33	55.00	45.00
FS620PWU CO	38.56	7.13 c	62.33	37.33	56.00	44.00
B2433PW CO	40.70	8.56 bc	61.66	35.33	51.00	49.00
P3016VYHR CO	43.33	11.33 a	62.33	34.66	59.66	40.33
Means	41.50	8.64	63.38	34.02	55.36	44.63
p-value	0.69 ^{ns}	0.00*	0.79 ^{ns}	0.31 ^{ns}	0.40 ^{ns}	0.40 ^{ns}
CV (%)	10.55	13.79	4.75	8.64	8.06	9.99
dms-Tukey-5%	13.02	3.54	8.95	8.74	13.27	13.26

*Means followed by equal letters in the columns do not differ from each other by Tukey test at 5% probability level. ^{ns}- not significant and * significant by Tukey test at 5% probability level. CV: coefficient of variation. p-value: probability of the analysis of variance F test. dms: Least significant difference at 5% probability level by Tukey test.

Table 5. In-vitro dry matter digestibility at 24 hours (IVDMD24h), in-vitro dry matter digestibility at 48 hours (IVDMD48h), in-vitro neutral detergent fiber digestibility at 24 hours (IVNDFD24h) and in-vitro neutral detergent fiber digestibility at 48 hours (IVNDFD48h), metabolizable energy (ME) and digestible energy (DE) in the forage from maize genotypes grown in the 2023/2024 season.

HYBRIDS	IVDMD24h	IVDMD48h	IVNDFD24h	IVNDFD48h	ME	DE
	-----%-----				Mcal kg	
BM3069 PRO3	73.33	80.33	39.00 b	55.00	2.75	3.16
BM3066 PRO3	76.00	83.33	45.00 ab	61.33	2.74	3.16
HLX2124 PRO3	72.66	80.00	42.00 ab	57.66	2.61	3.03
HLX2104 PRO3	72.66	81.00	41.33 ab	59.33	2.66	3.08
HL2065M PRO3	75.66	82.33	41.33 ab	58.33	2.78	3.19
SHS7990 PRO3	75.66	82.66	44.00 ab	60.00	2.73	3.15
SHS7970 PRO3	74.00	81.00	43.00 ab	58.66	2.68	3.10
HLX2162 CO	77.00	83.00	48.33 a	60.66	2.71	3.13
HLX2277 CO	74.00	79.66	45.00 ab	56.66	2.65	3.07
FS620PWU CO	73.33	80.33	43.66 ab	58.66	2.62	3.04
B2433PW CO	73.66	80.00	43.33 ab	57.33	2.61	3.03
P3016VYHR CO	74.66	81.00	44.00 ab	58.00	2.66	3.08
Means	74.38	81.22	43.33	58.47	3.10	2.68
p-value	0.81 ^{ns}	0.79 ^{ns}	0.02*	0.55 ^{ns}	0.91 ^{ns}	0.90 ^{ns}
CV (%)	4.25	3.48	5.72	5.43	4.68	5.45
dms-Tukey-5%	9.40	8.40	7.37	9.44	0.43	0.43

*Means followed by same letters in the columns do not differ from each other by Tukey test at 5% probability level. ^{ns}- not significant and * significant by Tukey test at 5% probability level. CV: coefficient of variation. p-value: probability of the analysis of variance F test. dms: Least significant difference at 5% probability level by Tukey test.

and NDF=45.11%), highlighting the quality of the fibrous fraction of the genetic materials evaluated. Corroborating the results found, Tres et al. (2014) observed values between 41.98% and 47.00% in the *in-vitro* NDF digestibility of thirty maize genotypes in two years of evaluation. Additionally, the variation in the digestibility pattern of maize plants may be due to differences in the concentration and dilution of nutrients existing in the hybrids at the time of harvest (Tres et al., 2014).

Conclusions

The hybrid HLX2162 CO stands out in plant height, kernel rows per ear, kernels per row, and grain yield. Additionally, it exhibits the highest levels of water-soluble carbohydrates and higher *in vitro* NDF digestibility in the forage, making it recommended for the evaluated edphoclimatic conditions.

The forage from the different corn hybrids shows high coefficients of *in vitro* dry matter digestibility and NDF digestibility, with average digestible and metabolizable energy contents of 3.10 Mcal.kg⁻¹ and 2.68 Mcal.kg⁻¹, respectively, corrected to 90.17% dry matter.

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Author's Contributions

Conceptual research: Molina, L.R.S.; Araújo, E.O.; da Silva, J.W.F.; Data Collection: Molina, L.R.S.; Pereira, T.O.; Silva, E.M.F.; Paulino, G.M.; Field supervision: Molina, L.R.S.; Silva, E.M.F.; da Silva, J.W.F.; Data analysis and interpretation: Molina, L.R.S.; Araújo, E.O.; Sousa, N.M.; Writing and editing: Molina, L.R.S.; Araújo, E.O.; Sousa, N.M.

Data Availability Statement

Data available upon request to authors.

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