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Fermentation dynamics and quality of maize silage with Pigeon pea

Dinâmica da fermentação e qualidade da silagem de milho com feijão guandu

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Highlights

Levels above 60% of Pigeon pea in silages compromise their fermentative profile.

Mixed silage combined with adequate levels is viable alternative to increase the CP.

Abstract

Tropical legumes are used to prepare mixed silages to enrich the crude protein (CP) content. In This context, objective of this study was to evaluate the dynamics of fermentation and quality of maize silage with different levels of Pigeon pea. The experimental design was entirely randomized, with four repetitions. The treatments comprised maize silages with six levels of added Pigeon pea (0, 20, 40, 60, 80, and 100%), calculated based on natural matter. The maize hybrid and Pigeon pea varieties used were B 2800 PWU and *Cajanus cajan* cv. BRS Mandarin, respectively. For the silage, the maize and Pigeon pea were harvested when they reached 335.7 g kg^{-1} dry matter (DM) and 281.3 g kg^{-1} DM, respectively. The results revealed that the added of up to 40% Pigeon pea in maize silages promote nutritive increment without compromising their fermentative profile of the silage. Exclusive Pigeon pea silage (100%) undergoes fermentative losses that compromise the silage quality. Therefore, mixed silages of maize with Pigeon pea, with appropriate levels of addition, are a viable alternative to increase the nutritive value of silages, mainly the CP content, contributing to reducing the cost of acquisition of protein salts.

Key words: Organic acids. *Cajanus cajan* cv. BRS Mandarin. Bromatological composition. Forage conservation. *Zea mays* L.

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Resumo

As leguminosas tropicais têm sido utilizadas para a confecção de silagens mistas para enriquecer os teores de proteína bruta (PB). Neste contexto, o objetivo deste estudo foi avaliar a dinâmica da fermentação e qualidade da silagem de milho com níveis de feijão guandu. O delineamento experimental utilizado foi o inteiramente casualizado, com quatro repetições. Os tratamentos foram constituídos da silagem de milho com seis níveis de feijão guandu (0; 20; 40; 60, 80 e 100%), calculado com base na matéria natural. O híbrido de milho e a variedade de feijão guandu utilizados foram o B 2800 PWU e o *Cajanus cajan* cv. BRS Mandarim, respectivamente. Para a ensilagem, o milho e o feijão guandu foram colhidos quando atingiram 335,7 g kg^{-1} de MS (matéria seca) e 281,3 g kg^{-1} MS, respectivamente. Os resultados mostraram que a adição de até 40% de feijão guandu na ensilagens de milho promove incremento nutritivo sem comprometer o seu perfil fermentativo da silagem. Silagem exclusiva de feijão guandu apresenta perdas fermentativas que compromete a qualidade da silagem. Portanto, silagens mistas de milho com feijão guandu, combinadas com níveis adequados de adição, torna-se alternativa viável para incrementar o valor nutritivo da silagem, principalmente os teores de PB, contribuindo com redução do custo com aquisição de sais proteínados.
Palavras-chave: Ácidos orgânicos. *Cajanus cajan* cv. BRS Mandarim. Composição bromatológica. Conservação de forragem. *Zea mays* L.

Introduction

Silage is the main form of volume storage used worldwide. This method is advantageous because it ensures the supply of palatable food throughout the year (Souza et al., 2019). Among the annual crops used for silage production, maize has been considered the standard for several years because of its high green mass yield, fermentation quality, and maintained nutritional value of the ensiled mass (Lima et al., 2022). However, the partial replacement of traditional maize crops with tropical legumes in the silage process has aroused interest and been widely used in cattle feed with positive results (Epifanio et al., 2014; Ligoski et al., 2020).

Pigeon pea, a legume highlighted in animal feed, is one of the main legumes grown in different regions worldwide, is highly palatable, and produces high amounts of forage with high protein and mineral content during the dry season (Silva et al., 2018a; Ligoski et al., 2020). This legume is an ideal cheap source of protein and can replace other sources of animal feed, with high yields (up to 22%) of crude protein (CP) (Abebe, 2022).

Although several studies have demonstrated the positive results of using legumes in silages (Souza et al., 2014; Carvalho et al., 2016; Ribeiro et al., 2020; Araújo et al., 2022), few have considered Pigeon pea. The added of legumes in the silage of annual crops, such as maize, can promote increased levels of CP in silage offered to animals, reinforcing the positive contributions of the presence of legumes to the quality of food (Ligoski et al., 2020) and reducing the cost of acquisition of protein salts and/or concentrates.

However, little information is available in the literature on maize silages with different proportions of Pigeon pea, as well as the best addition level of the legume to provide positive increments in the bromatological composition without affecting the fermentative characteristics of the silage. Therefore, studies that seek to improve the bromatological quality of silages are important. Provided the nutritional characteristics of maize and Pigeon pea, we hypothesized that the added of Pigeon pea in mixed maize silages would increase the CP content of the silage without compromising the fermentative characteristics. Thus, objective of this study was to evaluate the dynamics of fermentation and quality of maize silage with different levels of Pigeon pea.

Materials and Methods

Experimental site description, statistical design, treatments, and crop planting

The experiment was conducted at the Federal Institute Goiano, Rio Verde Campus, Brazil, during the second harvest of 2021. The experimental design was entirely randomized, with three repetitions. The treatments comprised maize silages with six levels of Pigeon pea (0; 20; 40; 60, 80 and 100%), calculated based on the natural matter, totaling 24 experimental silos. The maize hybrid used was B 2800 PWU (early cycle and high grain-yield potential), and the Pigeon pea variety was *Cajanus cajan* cv. BRS Mandarin.

The crops were sown separately on February 26, 2021. Six 3 m-long rows, spaced 0.50 m apart, were used for plotting both the crops. Maize and Pigeon pea were sown at a depth of 3 cm. During sowing, 100 kg ha^{-1} of P_2O_5 was applied as a source of simple superphosphate, and 20 kg ha^{-1} of FTE BR 12 (9% Zn, 1.8% B, 0.8% Cu, 2% Mn, 3.5% Fe, and 0.1 Mo). When the maize plants presented three to six completely developed leaves, fertilization coverage was performed by applying 120 and 80 kg ha^{-1} of N and K_2O, respectively, from urea and potassium chloride sources. For Pigeon pea, 80 kg ha^{-1} K_2O was applied at 30 and 60 days after sowing (DAS).

The maize was phytosanitarily controlled throughout crop development, with two applications of insecticide Lannate (methomyl active ingredient) in a proportion of 0.4 L ha^{-1} of commercial product. The weeds were controlled manually.

Crop silage

For ensiling, the crops were harvested on June 5, 2022 in a 100-day development cycle, with a dry matter (DM) content of 335.7 g kg^{-1} and 281.3 g kg^{-1} for maize and Pigeon pea, respectively. Both crops were harvested 20 cm above the ground using a back grazer. Subsequently, the materials were chopped separately in a forage grinder into approximately 10 mm particles.

The maize was homogenized with different proportions of Pigeon pea (0%, 20%, 40%, 60%, 80%, and 100%) and stored in PVC experimental silos measuring 10 cm in diameter and 40 cm in length. Subsequently, the silos were compacted with an iron pendulum, closed with PVC lids, and sealed with adhesive tape to prevent the entry of air. The silos were then stored at room temperature and protected from rain and sunlight.

Bromatological analysis before silage

Analyses were performed (before ensiling) on maize and Pigeon pea raw material (Table 1) to determine the dry matter (DM), crude protein (CP), lignin and ether extract (EE) content following the methodologies described by the Association Official Analytical Chemists [AOAC] (1990). Neutral detergent fiber (NDF) and acid detergent fiber (ADF) contents were determined according to the method described by Mertens (2002). Total digestible nutrients (TDN) were calculated using the equation proposed by Chandler (1990). To determine the *in vitro* dry matter digestibility (IVDMD), the technique described by Tilley and Terry (1963) was used, adapted to the artificial rumen, developed by ANKON®, using the "Daisy incubator" instrument of Ankom Technology (in vitro true digestibility- IVTD).

Table 1
Chemical bromatological composition of maize and Pigeon pea whole-plant

Chemical composition	Maize	Pigeon pea
DM (g kg^{-1} DM)	335.7	281.3
CP (g kg^{-1} DM)	76.5	157.0
NDF (g kg^{-1} DM)	564.2	603,9
ADF (g kg^{-1} DM)	286.7	363.5
EE (g kg^{-1} DM)	45.1	21.8
Lignin (g kg^{-1} DM)	28.07	45.4
IVDMD (g kg^{-1} DM)	650.4	588.1
TDN (g kg^{-1} DM)	602.5	570.6

DM: dry matter; CP: crude protein; NDF: neutral detergent fiber; ADF: acid detergent fiber; EE: ether extract; IVDMD: in vitro dry matter digestibility; TDN: total digestible nutrients.

Silage analysis

After 53 days of fermentation, the silos were opened, and the upper and lower portions were discarded. The central portion of the silo was homogenized and placed in a plastic tray. Part of the fresh silage was separated for analyzing the following fermentative parameters: buffering capacity, pH, and ammoniacal nitrogen in total nitrogen (N-NH_3), following the method described by (Bolsen et al., 1992).

The pH and buffering capacity were analyzed immediately after opening the silos to avoid alterations in the expected values owing to heat and humidity. To determine ammoniacal nitrogen, the silage was frozen to inactivate the anaerobic bacteria, thus preventing N volatilization. Subsequently, the samples were thawed for extraction of juice (Bolsen et al., 1992). Organic acids were determined using a Shimadzu SPD-10A VP (HPLC) liquid chromatograph coupled with an ultraviolet (UV) detector at 210 nm wavelength according to Kung and Shaver (2001). The total DM and effluent production losses were determined according to the methodology proposed by Jobim et al. (2007).

The remaining portion of the material (approximately 0.5 kg) was weighed and dried in a forced ventilation oven at 55ºC until constant weight was obtained. The samples were then ground in a knife mill with a 1 mm sieve, and stored in plastic containers. The chemical and bromatological characteristics of the silage were analyzed according to the methodology described above for fresh material.

Statistical analysis

The data were subjected to analysis of variance using the R program version R-3.1.1 (R Core Team [R], 2014), using the ExpDes package, and the Pigeon pea doses were evaluated using regression analysis, with standard error of the mean, using the Sigma Plot program.

Multivariate factor analysis was performed by considering the averages of the variables for each treatment using the MVar.pt computational package of the R program. Factor analysis was also performed by inverting the sign of the pH, buffering capacity, $N\text{-}NH_3$, acetic acid, propionic acid, butyric acid, total losses of DM, NDF, ADF, and lignin, while the other variables (production of effluent, lactic acid, CP, IVDMD, EE, and TDN) were kept in sign. This sign inversion was performed to ensure consistency in the direction between all the variables; that is, the higher the value, the better. Subsequently, regression analysis of the scores of the first factor was performed as a function of dosage.

Results and Discussion

Fermentative characteristics of silages

The added of Pigeon pea in maize silage influenced its fermentation characteristics and nutritional quality. The pH of the silage increased linearly with the added of Pigeon pea in the ensiled mass (Figure 1a), and as the percentage of the legume increased, greater resistance was observed to the lowering of the silage pH. This increase in pH is associated with the higher buffering capacity of legumes compared with that of maize, influencing the stabilization of the silage, which occurs at pH values above 4.5, as demonstrated by Epifanio et al. (2016). However, the results observed for the added of up to 40% of Pigeon pea are within the appropriate range of 3.8 to 4.2 (McDonald et al., 1991).

The addition of Pigeon pea to maize silage also resulted in a linear increase in the buffering capacity (Figure 1b). This increase occurs because of the presence of buffering substances, such as potassium (K^+), calcium (Ca^{2+}), and magnesium (Mg^{2+}), which neutralize the organic acids formed by fermentation, and prevent the reduction in pH (Smith, 1962). Legumes have high concentrations of crude protein, low levels of soluble carbohydrates, and a high buffering capacity, making them susceptible to proteolysis during silage fermentation (Baghdadi et al., 2016). However, the values observed for up to 40% added level of Pigeon pea were within the appropriate range, which is below 20 eq.mg HCl/100 g DM (Ferrari & Lavezzo, 2001).

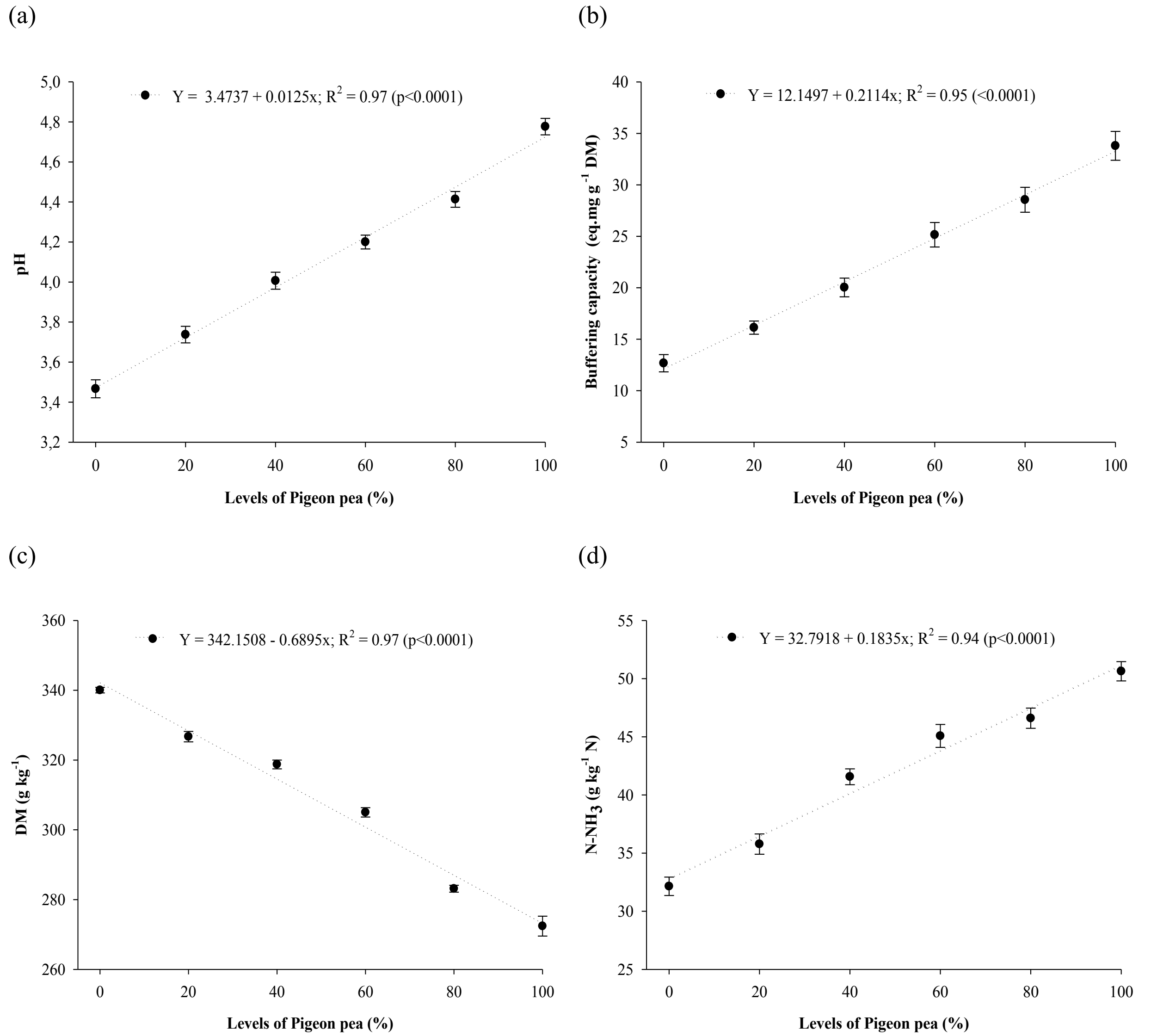

Figure 1. Values of pH (a), buffering capacity (b), contents of dry matter (DM) (c), and ammonia nitrogen (N-NH_3) (d) of maize silage with levels of Pigeon pea.
Vertical bars represent the standard deviation of the mean.

Figure 1c illustrates a decrease in DM content with increasing levels of Pigeon pea in the maize silage. This is because of the lower DM content of Pigeon pea at the time of cutting (281.39 g kg^{-1} DM) when compared with maize (335.7 g kg^{-1} DM). DM content is a key factor that directly affects fermentation during the ensiling process, thus influencing the quality of the produced silage (Paludo et al., 2020). To ensure optimal fermentation within the silo and consequently maintain the nutritional quality of the silage, the DM content of the ensiled mass should be between 300 and 350 g kg^{-1} DM (McDonald et al., 1991). Thus, the production of mixed silages is an important alternative to balance the DM content of ensiled material, especially for forage legumes that have a lower DM content at the time of cutting. Similar results were observed by Contreras-Govea et al. (2013), who reported a reduction in the DM of maize and forage sorghum silages for up to 75% added cowpea.

A linear increase was observed in $N\text{-}NH_3$ levels (Figure 1d) with increasing proportions of Pigeon pea in the silage. According to Kung et al. (2018), good-quality silages should have $N\text{-}NH_3$ levels below 100 g kg^{-1}. Increases in Pigeon pea levels also resulted in a linear increase in DM loss (Figure 2a). This was owing to the lower DM content at the time of ensiling compared with maize (Table 1). Pigeon pea and other legumes have high moisture, low concentrations of soluble carbohydrates, and high water activity, characteristics undesirable at the time of ensiling because they favor the occurrence of secondary fermentations, which are responsible for greater DM losses (Borreani et al., 2018). Notably, losses during the fermentation process can reduce DM recovery because the silo surface tends to increase oxygen penetration, causing the oxidation of organic matter and reduction in DM (Borreani et al., 2018). However, the Pigeon pea was harvested in a cycle of 100 days after sowing, which may have contributed to the increased legume DM content at the time of cutting and decreased severe losses.

Evaluating the influence of different proportions of soybean in maize silage, Parra et al. (2019) observed greater DM losses as the proportion of soybean increased in the soybean-maize mixture. Legume silages present a greater loss of DM owing to their greater buffering capacity, which hinders the lowering of pH and results in a prolonged fermentation process with high consumption of fermentable substrates (Bolson et al., 2022).

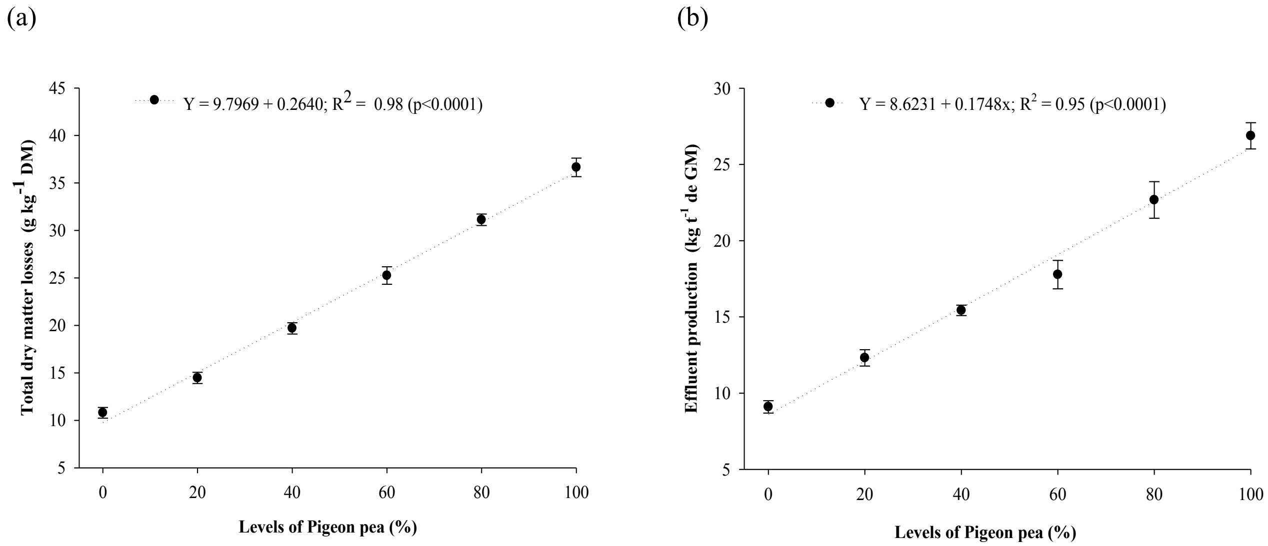

Figure 2. Total dry matter losses (a) and effluent production (b) of maize silage with levels of Pigeon pea. Vertical bars represent the standard deviation of the mean.

The losses from the effluent also increased with the proportion of Pigeon pea in the maize silage (Figure 2b). This increase was mainly owing to the lower DM content of Pigeon pea at the time of ensiling. The volume of effluent produced was related to the DM content of the ensiled forage species and the degree of compaction. The increase in effluent production is detrimental to the quality of silage because it favors the leaching of nutrients to the bottom of the silo, reducing the nutrient content of the silage in relation to the ensiled material (Queiroz et al., 2021).

There was a linear reduction in the lactic acid concentration (Figure 3a) with increasing levels of Pigeon pea in the maize silage. This effect may be associated with the lower content of soluble carbohydrates in legumes than in maize (Htet et al., 2022). Similar results were observed by Gülümser et al. (2021), who evaluated the potential of maize and legume silage and found reducing lactic acid concentrations with increasing levels of cowpea. Silage quality depends on the amount of lactic acid produced, which should be greater than 20.0 g kg^{-1} DM (Kung et al., 2018).

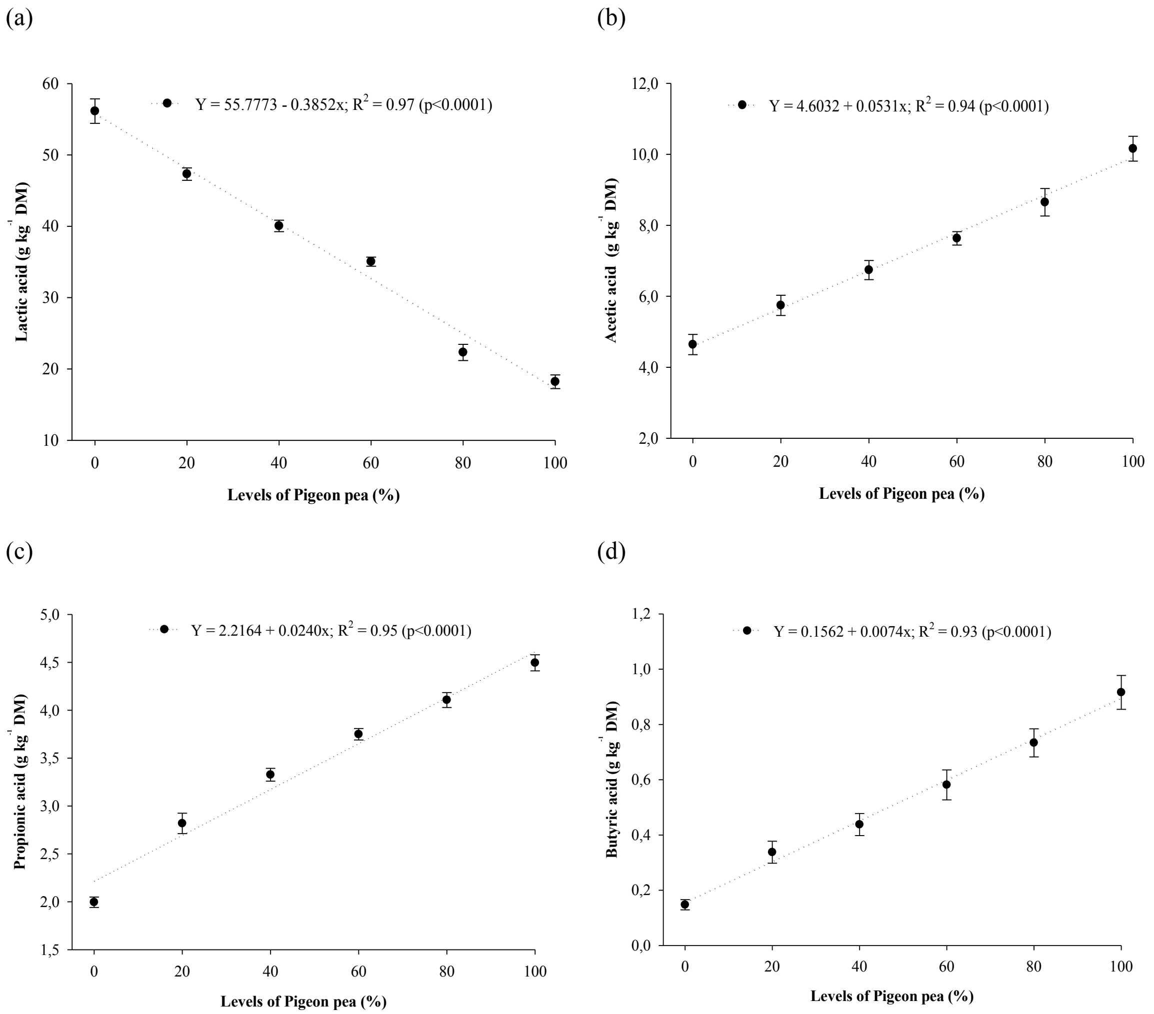

Figure 3. Lactic (a), acetic (b), butyric (c) and propionic (d) acid of maize silage with levels of Pigeon pea. Vertical bars represent the standard deviation of the mean.

Among the organic acids that contribute to the reduction in the pH of the ensiled mass, lactic acid is found in higher concentrations because of its higher dissociation constant (pKa = 3.86), thus playing a key role in the rapid drop in pH below 4.20 during the fermentation process (Souza et al., 2019). Therefore, there is increasing interest in including forage plants in mixed silages to improve the nutritional quality and reduce fermentation losses during the process (Drouin et al., 2021), especially for the production of Pigeon pea-exclusive silages, which did not reach lactic acid values higher than 20.0 g kg^{-1} DM in the present study.

The addition of Pigeon pea resulted in a linear increase in the acetic acid concentration (Figure 3b). Regardless of this increase, the acetic acid concentrations in all silages were within the classification standard for well-preserved silages, below 20 g kg^{-1} DM, and matched the results observed by Epifanio et al. (2016). The concentrations of propionic and butyric acid also increased linearly with increments in legume proportions in the silage (Figure 3c and d); however, even for 100% Pigeon pea silage, the values for these acids were within the appropriate ranges (less than 5 and 1 g kg^{-1} DM, respectively), according to Kung et al. (2018).

The low values of acetic, propionic, and butyric acids obtained in the silages demonstrate that the DM content of maize (354.7 g kg^{-1} DM) and Pigeon pea (281.4 g kg^{-1} DM) at the time of cutting were adequate, which contributed to the predominant activity of the bacterial genus Lactobacillus, producers of lactic acid, and consequent inhibition of the action of the bacterium Clostridium, thus ensuring adequate fermentation to preserve the ensiled mass, through the rapid fall of pH.

Quality of silages

Considering the CP content (Figure 4a), there was a linear increase with increasing levels of Pigeon pea, which resulted in 90.3, 97.4, 113.2, 120.7, and 135.8 g kg^{-1} DM content at 20, 40, 60, 80, and 100% levels, respectively, corroborating the positive contribution of the added of Pigeon pea in improving the quality of silage-exclusive maize. This increase is attributed to the higher CP content of the legume at the time of cutting (157 g kg^{-1} DM) compared with that of maize (76.5 g kg^{-1} DM), and exhibits the benefits and relevance of mixed silage production, as one of its main advantages is improving the nutritive value of annual crop silages (Paludo et al., 2020). Furthermore, the result demonstrates the potential of Pigeon pea in mixed silage compositions, mainly in relation to CP content, and consequently contributes to reducing the cost of acquisition of protein salts, aimed at protein supply, to improve the diet of cattle. Similar results were observed by Pereira et al. (2019) and Ligoski et al. (2020), who reported an increase in the CP content of the silage by including Pigeon pea in sugarcane and maize silages intercropped with Xaraes palisade grass silage, respectively.

Pigeon pea is considered one of the main legumes for the low-cost recovery of degraded pastures because of its positive contributions to the system, such as excellent development in low-fertility soils, high DM production, and biological nitrogen fixation, resulting in improved soil fertility (Singh et al., 2018; Ligoski et al., 2020; Costa et al., 2021; Musokwa & Mafongoya, 2021). Thus, cultivating legumes for direct grazing and using them as additives in the production of mixed silage is of utmost importance in production systems that seek greater sustainability.

A quadratic reduction was observed for ether extract (Figure 4b), where the minimum point (23.93 g kg^{-1} DM) was reached at 86.71% added level of Pigeon pea. This reduction can be explained by the lower fat content of Pigeon pea (Table 1) compared with that of maize. According to Bueno et al. (2020), well-preserved silages have an ether extract content similar to that of the ensiled material, because lipids are not typical fuels for the fermentation process, and similar results were observed in this study.

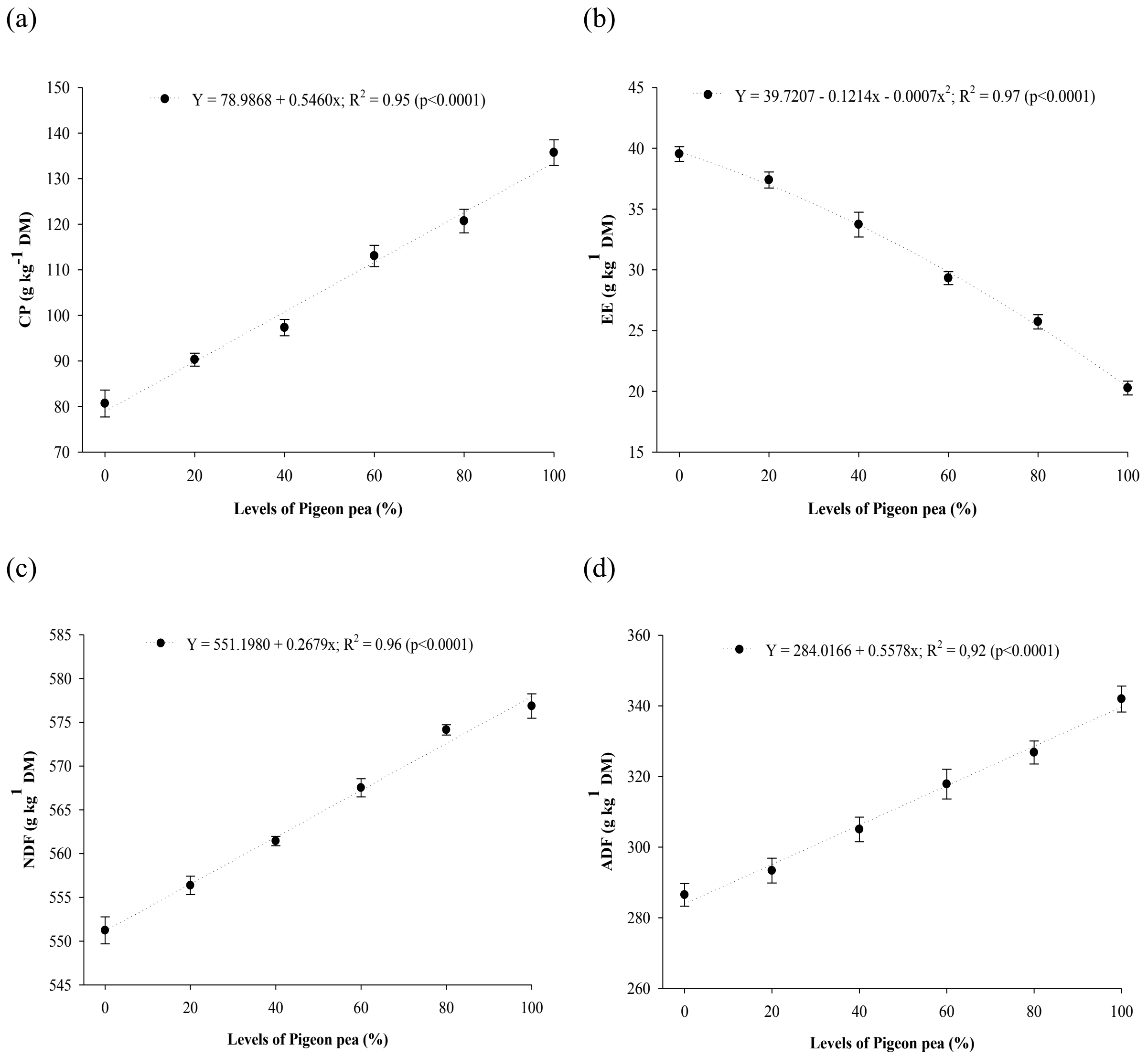

Figure 4. Contents of crude protein (CP) (a), ether extract (EE) (b), neutral detergent fiber (NDF) (c) and acid detergent fiber (ADF) (d) of maize silage with levels of Pigeon pea.
Vertical bars represent the standard deviation of the mean.

Increasing levels of Pigeon pea in the maize silages promoted a linear increase in the contents of NDF, ADF, and lignin (Figures 4c, d, and 5a). The increase can be explained by the dilution of the fibrous fractions because of the higher contents of NDF, ADF, and lignin in Pigeon pea (603.9, 363.5, and 45.01 g kg^{-1} DM) in relation to maize (594.2, 306.7, and 30.07 g kg^{-1}), respectively, at the time of cutting.

According to M. J. Silva et al. (2018b), the choice of a crop to be preserved through silage should consider the NDF content, which should be below 600 g kg^{-1}. Thus, the results observed in this study were within the appropriate range, even for 100% Pigeon pea silage. Foods with high NDF values have a ruminal filling effect, leading to a reduced DM consumption by animals. Thus, fibrous food intake reduces the rate of food passage through their digestive tract. NDF is important for the final quality of silage because it represents the vegetative portion of the silage. With advancing plant development, lignified structures are deposited in the NDF, reducing digestibility (Neumann et al., 2017).

ADF exhibits a negative correlation with digestibility. According to Van Soest (1994), ADF content below 400 g kg^{-1} indicates a high nutritive value of silage and DM digestibility. Regardless of the increase in the ADF levels with increasing levels of Pigeon pea in maize silage, the contents remained within the cited range, which indicates adequate nutritive value. Corroborating these results, Pereira et al. (2019) and Ligoski et al. (2020) observed an increase in the ADF and lignin contents with increasing levels of Pigeon pea in sugarcane silage and maize intercropped with Xaraes palisadegrass, respectively, which is explained by the large amount of fibrous stalks present in this legume.

Lignin content should be considered in the ensiling process because it is the main limiting factor in the degradation of the fibrous fraction of forages (Souza et al., 2019). During cell wall digestion by microorganisms present in the rumen, lignin content becomes a limiting factor because of its relationship with cellulose and hemicellulose, hindering the degradation of these fractions by microorganisms (Machado et al., 2020).

Increase in the levels of Pigeon pea in the silage resulted in a quadratic reduction in the IVDMD content, with a minimum point (607.37 g kg^{-1} DM) reached at 69.26% Pigeon pea level (Figure 5b). This reduction in digestibility is owing to the higher fibrous fractions present in the thatch of this legume, which contribute to the reduction in digestibility. Bao et al. (2022) evaluated the effect of different moisture contents and additives on silage characteristics and in vitro digestibility of Stylosanthes silage and found that IVDMD was negatively correlated with NDF and ADF contents, and that the higher the fiber content, the lower the digestibility, negatively affecting the consumption of DM by animals.

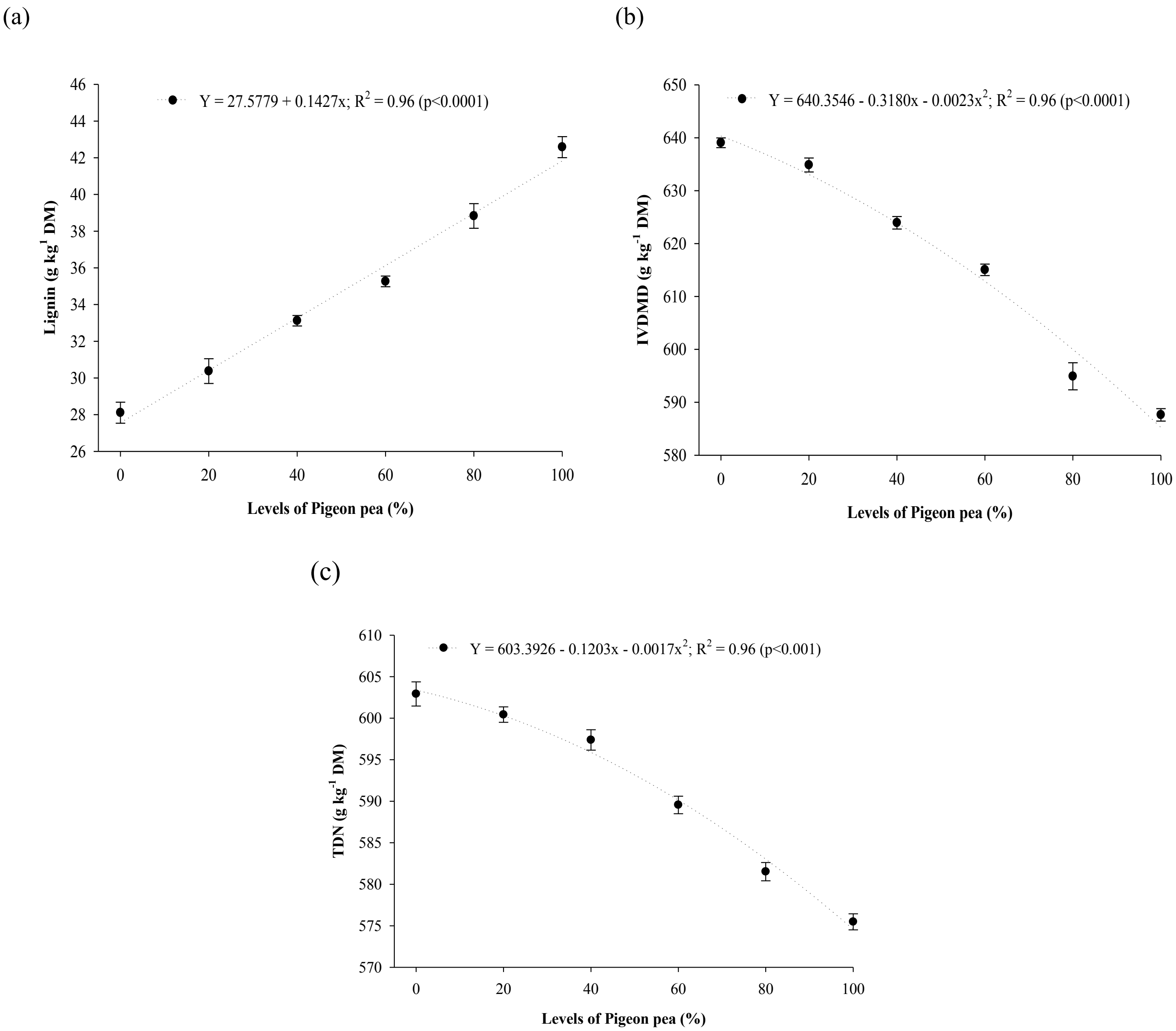

Figure 5. Lignin content (a), in vitro dry matter digestibility (IVDMD) (b) and total digestible nutrients (TDN) (c) of maize silage with levels of Pigeon pea.
Vertical bars represent the standard deviation of the mean.

TDN content also reduced with increasing levels of legume in the silage (Figure 5c), with the minimum point (597 g kg^{-1} DM) reached at the level of 35.38% Pigeon pea addition. This result can be explained by the lower EE content in Pigeon pea (Table 1). The TDN represents the energy content of food and is directly related to its fat content; that is, the higher the fat content of the food, the higher the TDN content, and its estimation is crucial for balancing diets (Marques et al., 2019).

Main component analysis of the fermentative profile and quality of silages

The first and second factors explained 99.44% of the total variation in the data, and the first factor accounted for 98.65% of the variation (Figure 6). The eigenvalues stabilized after the second factor, with a small fraction of the remaining variance. Notably, for a factor to be considered important, its eigenvalue must be larger than its mean. In the present study, the sum of the eigenvalues was one to 17, that is, the total number of variables, with a mean of 1. Only the first factor had an eigenvalue greater than 1. Considering all the variables of fermentative characteristics and nutritional quality, we verified that all of them exhibited a high correlation ($r > 0.97$) and factorial loads with the first factor. Factor I was the most important factor in explaining the behavior of the variables and treatments. It was also observed that the communality was greater than 0.99 for all variables, indicating that the factors explain the variables.

Based on multivariate factor analysis (Figure 6), the variables could be classified into two groups, one that was on the left, and the other on the right of the horizontal axis. From the angle between the arrows, a high positive correlation can be observed within the groups of variables. A strong negative correlation can be observed between the variables in different groups.

Factor I is represented horizontally in the scatterplot, whereas Factor II is represented vertically (Figure 6). The variables separated the treatments in a coherent manner, facilitating a graphical and objective understanding of the results. Higher than 40% Pigeon pea addition resulted in increased CP, NDF, and ADF contents; total losses of DM; production of effluent, pH, buffering capacity, N-NH3, acetic, propionic, and butyric acid; and reduction in lactic acid, DM, TDN, IVDMD, and EE contents, indicating the importance of adding adequate levels of the legume to maize silage, without compromising the quality of the silage.

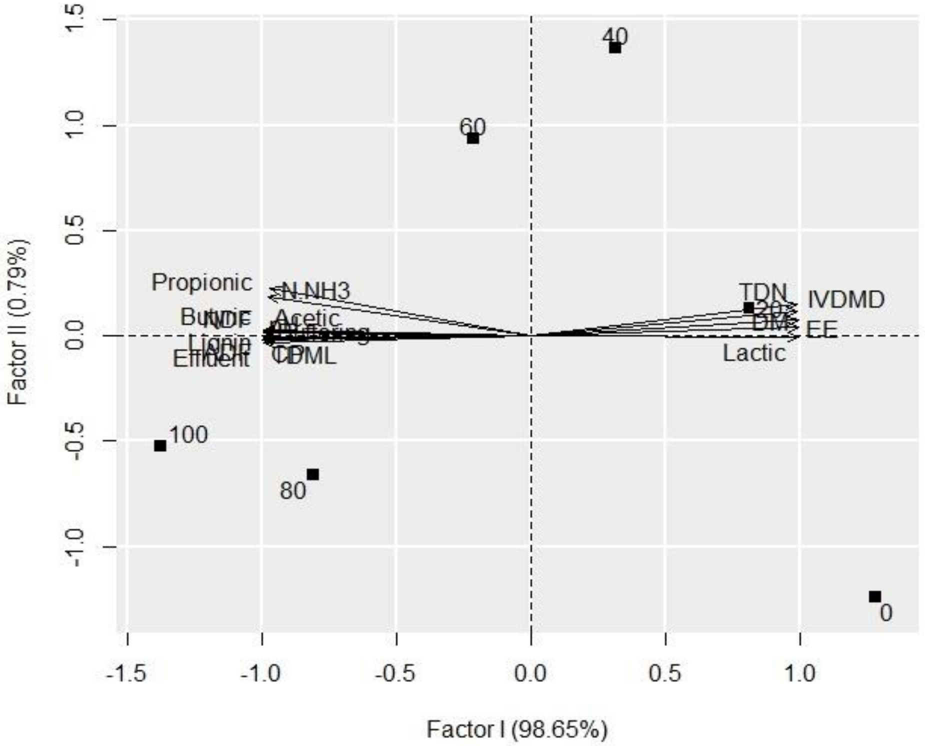

Figure 6. Two-dimensional scatter plot of the factorial loading matrix and scores of the 17 variables of fermentative characteristics and nutritional quality of maize silage with levels of Pigeon pea (0, 20, 40, 60, 80, and 100%).
DM: dry matter; TLDM: total losses of DM; Effluent: effluent production; pH; N-NH_3; ammonia nitrogen; Buffering: buffering capacity; Lactic: lactic acid; Acetic: acetic acid; Propionic: propionic acid; Butyric: butyric acid; CP: crude protein; NDF: neutral detergent fiber; ADF: acid detergent fiber; Lignin; EE: ether extract; IVDMD: in vitro dry matter digestibility and TDN: total digestible nutrients.

Conclusion

Added of up to 40% Pigeon pea in maize silage promotes nutritional increment without compromising the fermentative profile of the silage.

An exclusive silage of Pigeon pea undergoes fermentative losses that compromise the silage quality. Therefore, mixed silages of maize with Pigeon pea, with appropriate levels of addition, are a viable alternative to increase the nutritive value of silages, mainly the CP content, contributing to reducing the cost of acquisition of protein salts, with the aim of supplying protein in ruminant feed.

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