Revista Mexicana de Ciencias Agrícolas
REMEXCA

DOI: https://doi.org/10.29312/remexca.v15i2.3648

Investigation note

Nutritional value of soybean and buffel grass silages in different proportions

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Abstract

The availability of forage decreases during the dry season, so it is advisable to conserve forage and preferably it should contain high nutritional value. The present study aimed to evaluate the nutritive value of silages in different proportions of soybean and buffel grass forage under subtropical conditions. The treatments were three forage combinations: S50B50 (50% soybean forage + 50%buffel grass forage), S25B75 (25% soybean forage + 75% buffel grass forage) and B100 (100%buffel grass forage). The variables evaluated were: crude protein (CP), neutral detergent fiber, acid detergent fiber, ether extract, and metabolizable energy. Data were analyzed based on a completely randomized design with three repetitions and Tukey's mean comparison ((= 0.05). The S50B50 treatment presented the highest values of CP (128 *vs* 65 g kg^{-1}) and EE (28 *vs* 21 g kg^{-1}), compared to B100, which had the highest values of neutral detergent fiber (692 *vs* 513 g kg^{-1}) and acid detergent fiber (408 *vs* 355 g kg^{-1}). S25B75 and B100 treatments presented similar ME values (p> 0.05), 1.43 and 1.54 Mcal kg^{-1}, respectively, which were surpassed by S50B50 by 15% (1.71 Mcal kg^{-1}). Soybean and buffel grass silage could be an alternative for ruminant feeding during the dry season; in particular, the combination of 50% soybean forage and 50% buffel grass obtains the best nutrient profile.

Keywords:

feed supplementation, forage conservation, ruminant nutrition.

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In northeastern Mexico, rainfall is abundant during the summer and scarce the rest of the year (Vargas *et al*., 2007). This is directly related to forage production, which occurs seasonally; with abundance in the months of maximum rainfall (May-October), where pastures reach their maximum biomass production, reporting growth rates of up to 140 kg ha^{-1} day^{-1}, in contrast, during the months of minimum rainfall, grass growth is relatively null (Garay *et al*., 2019).

In addition to the decrease in forage production, the nutritional value of forage is deficient, which has crude protein and digestibility values lower than 50 and 400 g kg^{-1}, respectively (Ávila, 2013), so it is not possible to cover the requirements of ruminants through forage and especially protein (Belachew *et al*., 2013).

An alternative to counteract the lack of forage availability during the dry season is forage conservation, which can be through silage. With this method, much of the nutritional value of the forage was preserved, thereby significantly reducing the use of concentrates during the dry season (Garcés *et al*., 2004).

To increase the nutritional value of grass silages, mixtures with legumes have been made, as is the case of corn with soybean forage (Ni *et al*., 2018). In this sense Cheng *et al*. (2021), when evaluating soybean and corn forage mixtures in ratios of 25:75 and 50:50, reported significant differences in crude protein content (99 *vs* 147 g kg^{-1}) and *in vitro* digestibility (732 *vs* 787 g kg^{-1}).

Buffel grass [*Pennisetum ciliare* (L.) Link. (Syn. *Cenchrus ciliaris* L.)] is an adapted and frequently used forage in northeastern Mexico, mainly because it is a fast-growing grass and because it tolerates drought and intensive grazing (Garay-Martínez *et al*., 2017); however, its nutritional value is low, at 8 weeks, it has crude protein content and *in vitro* digestibility of ≈74 and ≈563 g kg^{-1}, respectively (Garay *et al*., 2020).

On the other hand, soybean forage [*Glycine max* (L.) Merrill] can be an alternative for supplementing ruminant feed, especially during the dry season (Ávila *et al*., 2014), as it has crude protein content and digestibility of ≈200 and ≈600 g kg^{-1}, respectively (Díaz *et al*., 2003; Touno *et al*., 2014), so the combination of both forages could generate silage with desirable nutritional characteristics. Therefore, this study aimed to evaluate the nutritional value of silages in different proportions of soybean and buffel grass forage under subtropical conditions.

The study was conducted under rainfed conditions from September to December 2019 at the Zootechnical Post of the Faculty of Engineering and Sciences of the Autonomous University of Tamaulipas, located in the municipality of Güémez, Tamaulipas, Mexico. The geographical coordinates are 23° 56’ 26.5” north latitude and 99° 05’ 59.9” west longitude, at 193 masl. The place’s climate is BS1(h’) hw (Vargas *et al*., 2007). The soil has a clayey texture, with a pH of 8.3, the sodium absorption ratio is 0.19, with organic matter and nitrogen contents of 4.2 and 0.25%, respectively (Garay-Martínez *et al*., 2018).

The treatments evaluated were silages of different proportions of buffel grass and soybean: S50B50 (50% soybean forage + 50% buffel grass forage), S25B75 (25% soybean forage + 75% buffel grass forage), and B100 (100% buffel grass forage). The soybean forage used was of the Huasteca 200 commercial variety, which was harvested 13 weeks after sowing and was in the reproductive stage R 6.0 (Fehr *et al*., 1971). The buffel grass was harvested from a meadow with a regrowth age of 10 weeks and was at the beginning of flowering.

For soybean cultivation, the preparation of land and control of weeds and pests was carried out according to the technological package for soybean production in the state of Tamaulipas (Maldonado *et al*., 2007). Sowing was carried out on September 7, 2019, in rows 0.8 m apart, where enough seed was deposited to ensure 20 ±2 plants per linear meter and thus obtain a density of ≈250 000 plants ha^{-1}.

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Two days before the silages were made, three samples were taken from each forage, which were separated into morphological components: leaf (leaflet + rachis + petiole), stem, pod (valves + seed), and dead material (> 60% of chlorotic tissue), and the methodology described by Garay-Martínez *et al*. (2018) was followed to determine forage yield and dry matter content (Table 1).

Table 1. Forage yield and morphological composition of soybean (*Glycine max* var. Huasteca 200) and buffel grass (*Pennisetum ciliare* cv. H-17) forage at the time of making silage.

Forage	TFM	TDM	DM	Leaf	Stem	Pod*	DMa
	(t ha^{-1})		(%)	(%)			
Huasteca 200	14.17	4.25	30	44	21	25	10
Buffel grass	7.69	2.69	35	50	35	-	15

TFM= total fresh matter; TDM= total dry matter; DM= dry matter; DMa= dead material; *= pod includes valves and grain.

To make the silages, 100 kg of forage of each material was harvested, which was cut at 5 and 10 cm above ground level for buffel grass and soybean, respectively. This forage was chopped to a particle size of 2.0±0.5 cm. Subsequently, 2% molasses (dissolved in water in 1:1 proportions) was added separately to each chopped forage on a wet matter basis and homogenized.

The forage was weighed and mixed in the different proportions to obtain the treatments described above. These mixtures were deposited in PVC microsilos (6” × 40 cm, with a fixed lid at one end), compacted, and sealed with a layer of polyethylene fixed with duct tape.

The microsilos were stored, and after 90 days, they were opened, and samples were obtained for analysis. Crude protein and ether extract (g kg^{-1}) were determined using the methodology described by the (AOAC, 2019). Neutral detergent fiber and acid detergent fiber (g kg^{-1}) were determined by the procedure described by Van Soest *et al*. (1991). Metabolizable energy (Mcal kg^{-1}) was estimated using the model of the AFRC (1993). Data were analyzed using the GLM procedure of SAS (2002) based on a completely randomized design with three repetitions. The mean comparison was made using Tukey’s test ((= 0.05).

The CP value differed (p< 0.01) between the treatments evaluated, with the combination in equal parts of soybean and buffel grass forage (S50B50) having the highest value, which was 38% and 97% higher compared to the S25B75 and B100 treatments, respectively. This coincides with reports with soybean silages where combinations similar to the present study were used, with the difference that in these studies, they used corn or sorghum forage (Ni *et al*., 2018) or corn stover (Cheng *et al*., 2021) instead of buffel grass.

On the other hand, as can be seen, as buffel grass was increased, the CP value decreased; this is due to the difference in protein content in soybean and buffel grass forage (Jahanzad *et al*., 2016).

In addition, the fact that all treatments included molasses helped to reduce the loss of CP content due to an increase in proteolysis (Ni *et al*., 2018), a situation that is common in legume ensiling processes when soluble carbohydrate sources are lacking. In contrast, when these types of carbohydrates are included, a rapid drop in pH is favored during the initial stages of fermentation, which results in an inhibition of the action of proteolytic bacteria, leading to a lower production of ammonia-N (Cheng *et al*., 2021) and consequently there is a lower loss of CP, as observed in the present study.

On the other hand, in the present study, when 25% of soybean forage and 75% of buffel grass were added, the CP value increased by 43% (from 65 to 93 g kg^{-1}). This ensures optimal activity of the rumen microorganism population and, therefore, adequate digestion of fiber, given that the minimum recommended CP concentration in grazing ruminant feed is 70 g kg^{-1} (Belachew *et al*., 2013).

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Regarding the content of NDF (*p*< 0.01) and ADF (*p*< 0.01), higher contents were found in silage with buffel grass alone. This can be explained by the use of molasses, which promoted an efficient transformation of sugars into lactic acid, reducing proteolysis (Rosa *et al*., 2020). In this regard, the inclusion of molasses in ensiling processes with soybean forage causes a higher reduction in pH values in the first 10 days of fermentation (Rosa *et al*., 2020), which is associated with the rapid development of lactic acid-producing bacteria.

The acidic pH inhibits the development of undesirable microorganisms, which preserves a higher cell content in the forages because the presence of cellulolytic enzymes is favored. These enzymes act on the cellulose contained in the cell wall of plants, breaking the #-1-4 glycosidic bonds, and releasing sugars, in such a way that molasses helps the release of additional sugars, thus promoting a more adequate fermentation process (Rosa *et al*., 2020).

In this same sense, the higher ADF content in the silage with buffel grass alone could be due to a lower hemicellulose content (Rosa *et al*., 2020), coupled with the fact that this type of silage is associated with a greater presence of organic acids (Ni *et al*., 2018), which hydrolyze the most digestible cell wall fraction during ensiling (Larsen *et al*., 2017) and this causes the nutritional quality of this type of silages to decrease.

Silage with equal proportions of soybean and buffel grass (S50B50) had the highest EE value (*p*< 0.01), 27% higher compared to the other treatments (Table 2). This behavior was due to the higher proportion of soybean forage, which contained 25% of valves and grain (Table 1), and the latter provides oil in high concentrations (Bernard, 2011).

Table 2. Nutritional value of silages in different proportions of soybean (*Glycine max*) and buffel grass (*Pennisetum ciliare*).

Treatment	CP	NDF	ADF	EE	ME
		(g kg^{-1})			(Mcal kg^{-1})
S50B50	128a	513c	355b	28a	1.71a
S25B75	93b	596b	389ab	23b	1.54b
B100	65c	692a	408a	21b	1.43b
P-value	<0.01	<0.01	<0.01	<0.01	<0.01

S50B50= 50% soybean forage + 50% buffel grass forage; S25B75: 25% soybean forage + 75% buffel grass forage; B100= 100% buffel grass forage; CP= crude protein; NDF= neutral detergent fiber; ADF= acid detergent fiber; EE= ether extract; ME= metabolizable energy. Literals (a, b, c) different between rows indicate a statistically significant difference (Tukey, (= 0.05).

Nonetheless, it should be noted that after the ensiling process, EE values tend to decrease (Ni *et al*., 2018; Cheng *et al*., 2021); the reason for this is not yet clearly known, but it is possible that the compound is lost as effluent by leaching (McDonald *et al*., 2002).

The ME value was 15% higher (1.71 *vs*. 1.49 Mcal kg^{-1}; *p*< 0.01) in the treatment with equal proportions of soybean and buffel grass (S50B50); this is likely because the ME value of buffel grass is lower than that of forage soybean, which is consistent with the results obtained by Blaunt *et al*. (2006); Cheng *et al*. (2021).

Conclusions

Making soybean and buffel grass silages could be an excellent alternative for feeding ruminants in the dry season, as the study showed that it is a silage suitable for ruminant feeding. In particular, the combination of 50% soybean forage and 50% buffel grass was the one that resulted in the silage with the best nutritional profile.

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Revista Mexicana de Ciencias Agrícolas

DOI: https://doi.org/10.29312/remexca.v15i2.3648

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Journal Information
Journal ID (publisher-id): remexca
Title: Revista mexicana de ciencias agrícolas
Abbreviated Title: Rev. Mex. Cienc. Agríc
ISSN (print): 2007-0934
Publisher: Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias

Article/Issue Information
Date received: 01 January 2024
Date accepted: 01 February 2024
Publication date: 02 April 2024
Publication date: March 2024
Volume: 15
Issue: 2
Electronic Location Identifier: e3648
DOI: 10.29312/remexca.v15i2.3648

Categories

Subject: Investigation note

Keywords:

Keywords:

feed supplementation

forage conservation

ruminant nutrition

Counts

Figures: 0

Tables: 2

Equations: 0

References: 25

Pages: 0