

A Comparative Analysis of Silver Leaf Desmodium and Mexican Sunflower as Protein Sources for Ruminants

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ARTICLE INFORMATION	ABSTRACT
Article history: Published: October 2026 Keywords: Crude Protein Crude Fiber Ash Moisture Ruminants	The rapid growth of the global population and increasing demand for animal-based foods have intensified the need for sustainable, high-quality protein sources in livestock production. Conventional protein-rich feeds are often costly and inaccessible to smallholder livestock producers creating a need to evaluate locally available alternatives. This study compared the nutritional composition of Mexican sunflower (<i>Tithonia diversifolia</i>) and silver leaf desmodium (<i>Desmodium uncinatum</i>) as potential ruminant feed resources. Plant samples were analyzed for moisture, crude ash, crude fiber and crude protein using standard laboratory procedures. Mexican sunflower had higher crude protein of 28.05% and ash of 14.70% contents than silver leaf desmodium which had 18.54% crude protein and 6.90% ash content. In contrast, silver leaf desmodium had higher crude fiber of 24.28% than Mexican sunflower with 6.56%. Both forages had high moisture contents of 77.70% and 82.30%, respectively which may limit safe storage and preservation. These findings suggest that Mexican sunflower is a promising protein supplement while silver leaf desmodium is a valuable fiber source for ruminants. Combining both forages could improve ration balance, reduce feed costs and support more sustainable livestock production.

1. Introduction

The global population is projected to reach 9.7 billion by 2050, making food security a major concern, especially in developing countries (Gu et al., 2021). Population growth has been driven by improvements in healthcare, increased life expectancy, and reduced infant mortality, and this trend is expected to continue in the coming decades (Gu et al., 2021). One major consequence is the increased consumption of animal-source foods such as meat, milk, fish, and eggs. Livestock contributes approximately 40% and 20% of total agricultural output in developed and developing countries, respectively, while supporting the livelihoods of about 1.3 billion people (FAO, n.d.). Rising incomes and changing dietary preferences in developing countries have further increased demand for animal-based protein (Henchion & Zimmermann, 2021).

This demand has placed pressure on animal production systems to become more efficient and sustainable. Nutrition is a key determinant of livestock health and productivity, contributing approximately 50–70% of overall performance. However, one of the greatest challenges in animal nutrition is obtaining sufficient high-quality protein at an affordable price. Conventional protein sources such as soybean meal and fishmeal are often expensive and subject to market volatility, making them less accessible to smallholder producers. There is therefore a need to explore alternative, locally available, and cost-effective protein sources. Mexican sunflower (*Tithonia diversifolia*) and silver leaf desmodium (*Desmodium uncinatum*) are two promising forage species that are adaptable to diverse climatic conditions and can be integrated into smallholder farming systems (Gualberto et al., 2011; Hueze et al., 2017). This study evaluated and compared the nutritional composition of these two forages as potential protein and fiber sources for ruminants.

2. Methodology

2.1 Study Area

The study was conducted in Meru County, Kenya. Meru County is located Upper Eastern region of Mount Kenya.

2.2 Sample Collection and Preparation

Fresh leaf samples of Mexican sunflower and silver leaf desmodium were collected from the university farm. Samples were cleaned, chopped and mixed thoroughly. For all analyzes, samples were oven-dried at 60°C to constant weight and ground to pass through a 1 mm sieve. All nutrient values are expressed on a dry matter basis.

2.3 Determination of Moisture Content

Porcelain crucibles (PC) were dried in an oven at 105°C for 1 hour, cooled in a desiccator and weighed. Approximately 2 g of fresh feed sample was weighed into the dried PC. The PC with sample was then placed in an oven at 105°C for 7 hours. After drying, the PC with sample was cooled in a desiccator and weighed again. Moisture content (MC %) was calculated using the formula by Nurdianti et al. (2024) as shown in equation (Eq) 1.

$$MC(\%) = \frac{W_w - W_d}{W_w} \times 100 \quad \text{Eq. 1}$$

Where; W_w = Weight of the fresh sample (g) and W_d = Weight of the dried sample (g)

2.4 Determination of Crude Ash Content

2 grams (g) of dried, ground feed were weighed into a PC and incinerated in a muffle furnace at 550°C for 4 hours. The PC was then cooled and weighed again. Crude ash was calculated using the AOAC (2023) formula as shown in Eq.2.

$$\text{Crude Ash (\%)} = \frac{W_a}{W_s} \times 100 \quad \text{Eq. 2}$$

Where; W_a = Weight of ash remaining after incineration (g) and W_s = Weight of the original dried feed sample (g)

2.5 Determination of Crude Fiber

The 2 g of dried, ground feed sample were weighed into a Berzelius beaker. A 0.255 N sulfuric acid solution was added and the mixture was heated. After acid digestion, the residue was filtered using muslin cloth followed by alkali digestion with 0.313 N sodium hydroxide solution. The residue was washed, dried and incinerated in a muffle furnace at 550°C. Crude fiber (CF) was calculated using the AOAC (2023) formula as shown in equation (Eq) 3.

$$\text{Crude Fibre (\%)} = \frac{W_1 - W_2}{W_s} \times 100 \quad \text{Eq.3}$$

Where; W_1 = Weight of dried residue after acid and alkali digestion (g), W_2 = Weight of ash after incineration (g) and W_s = Weight of original sample (g)

2.6 Determination of Protein Content

Crude protein (CP) was determined using the Kjeldahl method. Approximately 2 g of dried, ground feed sample was weighed into digestion tubes with copper sulfate (CuSO_4) and concentrated sulfuric acid. The mixture was heated at 380°C to break nitrogen bonds and convert nitrogen to ammonium ions. After digestion, the sample was diluted transferred to a distillation unit and distilled to release ammonia which was trapped in boric acid solution. The captured ammonia was titrated using standardized 0.1 N hydrochloric acid. The percentage of nitrogen was calculated using the formula below with a conversion factor of 1.4007 as shown in equation (Eq) 4

$$\text{Nitrogen (\%)} = \frac{V_b - V_s \times N \times 1.4007}{W_s} \times 100 \quad \text{Eq.4}$$

Where; V_s = Volume of acid used for sample titration (mL), V_b = Volume of acid used for blank titration (mL), N = Normality of acid and W_s = Weight of sample (g)

Crude protein was then calculated as:

$$\text{Crude Protein (\%)} = \text{Nitrogen (\%)} \times 6.25 \text{ (conversion factor)}$$

2.7 Statistical Analysis

Data were summarized using descriptive statistics (means). The study used a comparative laboratory analysis design. Inferential statistics were not included because replication was not part of the available dataset. Results are therefore presented as numerical comparisons and differences are described as absolute and relative differences rather than statistically significant differences.

3. Findings

3.1 Comparative Summary of the Parameters.

The nutritional composition of the two forages differed markedly between silver leaf desmodium and Mexican sunflower as illustrated in Table 1.

Table 1: Comparative nutritional composition of silver leaf desmodium and Mexican sunflower (dry matter basis)

Parameter	Silver leaf desmodium	Mexican sunflower	Absolute difference	Relative difference
Dry matter (%)	22.30	16.90	-5.40	-24.2%
Moisture (%)	77.70	82.30	+4.60	+5.9%
Ash (%)	6.90	14.70	+7.80	+113.0%
Crude fiber (%)	24.28	6.56	-17.72	-73.0%
Nitrogen (%)	2.97	4.49	+1.52	+51.2%
Crude protein (%)	18.54	28.05	+9.51	+51.3%

3.2 Moisture Content

Silver leaf desmodium had a dry matter content of 22.30% corresponding to a moisture content of 77.70%. Mexican sunflower had a dry matter content of 16.90% corresponding to a moisture content of 82.30%. Mexican sunflower had a higher moisture content than silver leaf desmodium by 4.60 percentage points (Table 1).

3.3 Crude Ash Content

Silver leaf desmodium recorded an ash content of 6.90% while Mexican sunflower had an ash content of 14.70%. Mexican sunflower therefore had a higher ash content by 7.80 percentage points representing a 113% increase relative to silver leaf desmodium (Table 1).

3.4 Crude Fiber

Silver leaf desmodium had a crude fiber content of 24.28% while Mexican sunflower had 6.56%. Silver leaf desmodium therefore had a higher crude fiber content by 17.72 percentage points which is approximately 270% higher than Mexican sunflower (Table 1).

3.5 Crude Protein

Mexican sunflower had a nitrogen content of 4.49% corresponding to a crude protein content of 28.05%. Silver leaf desmodium had a nitrogen content of 2.97% corresponding to a crude protein content of 18.54%. Mexican sunflower therefore had a higher crude protein content by 9.51 percentage points representing a 51% increase relative to silver leaf desmodium (Table 1).

3.6 Complementary Blending Analysis

Using the dry matter basis of the reported values, a linear blend were formulated using different proportions of Mexican sunflower and silver leaf desmodium to obtain varying nutritional characteristics. As the proportion of Mexican sunflower increased, the estimated crude protein and ash contents increased while crude fiber decreased. The 57:43 blend had the highest estimated crude protein of 24.0% and lowest crude fiber of 14.1% whereas the 15:85 blend had the highest crude fiber of 21.6%. The estimated nutrient contents of various blends are shown in Table 2.

Table 2: Estimated nutritional composition of dry matter blends

Blend	Mexican sunflower (%)	Silver leaf desmodium (%)	Estimated crude protein (%)	Estimated crude fiber (%)	Estimated ash (%)
High-fiber blend	15	85	20.0	21.6	8.1
Balanced blend	36	64	22.0	17.8	9.7
50:50 blend	50	50	23.3	15.4	10.8
High-protein blend	57	43	24.0	14.1	11.4

4. Discussion

4.1 Moisture Content

The moisture content of both forages was high with Mexican sunflower (82.30%) exceeding silver leaf desmodium (77.70%). High moisture in fresh forage is typical but it poses significant challenges for storage and preservation. At these moisture levels, microbial activity particularly mould growth is likely to occur leading to nutrient loss and potential mycotoxin contamination (Fink-Gremmels, 2008). This is a critical consideration for smallholder farmers who may lack access to adequate drying facilities. Ensiling could be a viable preservation method as anaerobic fermentation inhibits spoilage organisms and preserves nutrients (Mtengeti et al., 2021). However, the success of ensiling depends on achieving adequate compaction and rapid pH reduction. Mexican sunflower with its higher moisture may require wilting before ensiling to prevent effluent production and clostridial fermentation. From a feeding perspective, the high moisture content dilutes the nutrient density per unit fresh weight. Therefore, ration formulation must be based on dry matter intake to ensure animals receive adequate nutrients. The lower dry matter content of Mexican sunflower of 16.90% compared to silver leaf desmodium of 22.30% means that more fresh Mexican sunflower would be needed to supply the same amount of dry matter. This has practical implications for harvesting, transport and feeding logistics.

4.2 Crude Ash Content

The ash content of Mexican sunflower (14.70%) was more than double that of silver leaf desmodium (6.90%). Ash represents the total inorganic mineral content, and such a high value suggests that Mexican sunflower may be a richer source of minerals. This is consistent with reports that *Tithonia diversifolia* accumulates high levels of minerals, particularly calcium and potassium (Gualberto et al., 2011). However, it is important to note that ash content alone does not indicate the bioavailability of minerals or the presence of specific elements. High ash could also reflect soil contamination especially if samples were not thoroughly washed. Nevertheless, the relatively high ash content of Mexican sunflower indicates potential to contribute to the mineral requirements of ruminants particularly in tropical regions where mineral deficiencies are common (McDowell et al., 2020). In contrast, silver leaf desmodium had a lower ash content which may be adequate for maintenance but may require mineral supplementation in high-producing animals. A balanced approach would be to include both forages in the diet to meet both protein and mineral needs while avoiding excessive ash intake which could interfere with digestibility if it contains high levels of silica.

4.3 Crude Fiber Content

The crude fiber content of silver leaf desmodium (24.28%) was substantially higher than that of Mexican sunflower (6.56%). This difference is nutritionally significant. Fiber is essential for ruminants to maintain rumen health, stimulate chewing and support microbial fermentation (Van Soest, 1994). The high fiber content of silver leaf desmodium makes it an excellent basal forage for ruminants especially when combined with low-fiber, high-protein supplements. However, high fiber can also limit voluntary intake and digestibility if the fiber is highly lignified. The acid detergent fiber (ADF) and neutral detergent fiber (NDF) fractions would provide a more precise assessment of fiber quality but the crude fiber value still indicates that silver leaf desmodium is a valuable fiber source. In contrast, Mexican sunflower is low in fiber which could lead to rumen acidosis if fed as the sole forage. Therefore, Mexican sunflower should be used as a protein supplement alongside a fibrous basal diet. The complementary nature of these two forages is clear: silver leaf desmodium provides the structural fiber needed for rumen function while Mexican sunflower supplies readily fermentable protein. This supports the concept of blending them to achieve a more balanced ration.

4.4 Crude Protein Content

The crude protein content of Mexican sunflower (28.05%) was markedly higher than that of silver leaf desmodium (18.54%). Both values are within or above the range typically required for maintenance and production in ruminants (Godoi et al., 2024). The high CP of Mexican sunflower suggests it could serve as a valuable protein supplement potentially reducing the need for expensive commercial concentrates such as soybean meal. However, several caveats apply. First, the Kjeldahl method measures total nitrogen which includes non-protein nitrogen (NPN) such as nitrates and free amino acids. Ruminants can utilize NPN to a limited extent,

but excessive NPN can lead to ammonia toxicity. Therefore, the true protein content may be lower than the crude protein value. Second, the amino acid profile is unknown and a protein source is only as good as its essential amino acid balance. Third, the presence of anti-nutritional factors such as tannins or alkaloids could reduce protein digestibility. *Tithonia diversifolia* has been reported to contain tannins and other secondary metabolites that may affect palatability and digestibility at high inclusion levels (Hueze et al., 2017). Therefore, while the CP content is promising, feeding trials are needed to determine optimal inclusion rates. Silver leaf desmodium, with a moderate CP of 18.54%, is still a useful protein source especially for maintenance. Its protein is likely to be more rumen-degradable, which can support microbial growth. The combination of the two forages could provide a mix of rumen-degradable and bypass protein benefiting both microbial and animal protein supply.

4.5 Complementary Blending and Ration Formulation

The contrasting nutritional profiles of the two forages suggest that blending them could produce a more balanced ration. The linear blending analysis (Table 2) shows that a 50:50 dry matter blend would yield approximately 23.3% CP, 15.4% CF and 10.8% ash. This blend could meet the protein and fiber requirements for many classes of ruminants such as growing cattle or dry dairy cows. However, the fresh-weight proportions would differ due to the different moisture contents. For example, to achieve a 50:50 dry matter blend, a farmer would need to mix approximately 60 parts fresh Mexican sunflower with 40 parts fresh silver leaf desmodium, because Mexican sunflower has lower dry matter. This highlights the importance of dry matter basis in ration formulation. Furthermore, the blending analysis is theoretical and does not account for interactions such as associative effects on digestibility. For instance, high levels of soluble protein in Mexican sunflower could enhance fiber digestion in silver leaf desmodium by providing nitrogen to fibrolytic bacteria. Conversely, tannins in Mexican sunflower could bind protein and reduce its availability. Therefore, in vitro and in vivo studies are needed to validate the optimal inclusion levels and to assess animal performance.

4.6 Economic Viability and Sustainability

The use of these forages as alternative feed resources has significant economic and environmental implications. Commercial protein supplements are costly and often unavailable in rural areas making them inaccessible to smallholder farmers (Simoni et al., 2024). Mexican sunflower and silver leaf desmodium can be grown on-farm with minimal inputs, reducing feed costs and increasing resilience. Both species are adaptable to a range of climatic conditions and can be integrated into crop-livestock systems. Silver leaf desmodium, as a legume, fixes atmospheric nitrogen, improving soil fertility and reducing the need for synthetic fertilizers (Kariuki et al., 2022). This can lead to higher yields of subsequent crops and lower greenhouse gas emissions. Mexican sunflower, produces large amounts of biomass and can be used as a cover crop or green manure. Its deep root system helps recycle nutrients and improve soil structure. From a sustainability perspective, replacing imported feed with locally produced forages reduces the carbon footprint of livestock production. It also enhances biodiversity by providing habitat for pollinators and other beneficial organisms. However, farmers should be cautious about potential invasiveness of *Tithonia diversifolia* which can become weedy if not managed properly. Extension services should provide guidance on cultivation and utilization to maximize benefits and minimize risks.

5. Conclusion

Mexican sunflower had higher crude protein and ash contents, while silver leaf desmodium had higher crude fiber. Both forages had high moisture contents which may challenge storage and preservation. Mexican sunflower appears promising as a protein supplement while silver leaf desmodium is a valuable fiber source for ruminants. Combining both forages could help balance protein and fiber in ruminant rations, reduce dependence on commercial feeds and support sustainable livestock production. Further research is needed on digestibility, mineral composition, anti-nutritional factors and animal performance.

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