RESEARCH ARTICLE

Acacia Leaves: A Promising Alternative Feed Source in Addressing Feed Shortages and Enhancing Livestock Productivity

Sagi Raju[1], Devanaboyina Nagalakshmi[2], Nagireddy Nalini Kumari[3], Boini Sravanthi[3]*, Mende Ramyavasavi[4], Begari Divya[3]

Abstract

The availability of balanced feed with optimal chemical composition and metabolizable energy (ME) is a significant challenge in ruminant production globally, particularly in India. As the area dedicated to fodder cultivation declines due to competition with cash crops, alternative feed resources, such as tree species, are gaining attention. This study investigates the chemical composition, mineral content, and amino acid profile of *Acacia nilotica* leaves, which have been identified as a promising alternative feed source for ruminants. Acacia species, known for their resilience in harsh environments, contain high crude protein (17.69%), low detergent fiber, and significant amounts of essential minerals and amino acids, such as glutamic acid, aspartic acid, leucine, and lysine. The leaves are rich in trace minerals like iron, manganese, and zinc, which support various metabolic functions in animals. The study also highlights the suitability of *Acaci anilotica* leaves as a protein supplement for ruminants, particularly during the dry season when conventional fodder is scarce. The findings suggest that *Acacia nilotica* leaves have substantial nutritional value, offering an alternative to traditional fodder, with potential benefits for improving livestock productivity and sustainability in ruminant feeding systems.

Key words: *Acacia nilotica* leaves, Alternative feed resources, Livestock productivity, Nutrient deficits, Tree species.

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Introduction

The availability of feed with imbalanced proximate composition and metabolizable energy (ME) is a major challenge in ruminant production globally (Niderkorn and Boumont, 2009). According to the IGFRI Vision 2050, India currently faces a net deficit of 35.6% in green fodder, 10.95% in dry fodder, and 44% in concentrate feed ingredients. By 2050, the demand for green fodder is expected to reach 1,012 million tonnes, while the demand for dry fodder will rise to 631 million tonnes. The area dedicated to fodder production is steadily decreasing due to competition with cash crops. The growing demand for cereal grains for human consumption, combined with the shrinking land available for fodder cultivation, is significantly reducing the nutrient supply to ruminants (Cheema *et al.,* 2011). Several parts of the world including Africa, Ethiopia and India reveal that fodder trees and shrubs are valuable animal feed and play an important role in farming system due to their better adaptation to local environment and drought situation (Tsegaye *et al*., 2007). Trees require less management and care, and give consistent yield for a prolonged period (Dhillon *et al.,* 2023). Tree leaves are a valuable source of supplementary protein, vitamins, and minerals, contributing to improved microbial growth and digestion in ruminants (Cheema *et al*., 2011). While all parts of the tree can be used for feeding, leaves are particularly important due to their high crude protein content (Hassene *et al*., 2010).

Acacia is an important genus in the Leguminosae family, originally described by Linnaeus in 1773. There are approximately 1,380 species of acacia worldwide (Abdalla and Ahmad, 2023). Acacia species are a large group of woody plants, including shrubs, within the subfamily Mimosoidae (Dagba and Harris, 2014). These species remain green for most of the year and are known for their ability to thrive in dry, poor, and harsh environmental conditions (Mashamaite *et al.,* 2009; Mapiye *et al.,* 2011; Mathobela, 2018). Some common species of Acacia include *Acacia karroo, Acacia tortilis, Acacia nilotica, Acacia angustissima, Acacia saligna*, and *Acacia schaffneri*. It

[1]Department of Animal Nutrition, College of Veterinary Science, Warangal-506005, PVNRTGVU, Telangana, India

[2]College of Fisheries Science, Pebbair-509104, PVNRTGVU, Telangana, India

[3]Department of Animal Nutrition, College of Veterinary Science, Rajendranagar, PVNRTGVU, Hyderabad-500030, Telangana, India

[4]Division of Animal Nutrition, ICAR- Indian Veterinary Research Institute, Izatnagar, Bareilly-243122, Uttar Pradesh, India

Corresponding Author: Dr. Boini Sravanthi, Department of Animal Nutrition, College of Veterinary Science, Rajendranagar, PVNRTGVU, Hyderabad-500030, Telangana, India. e-mail: boinisravanthi1998@gmail.com

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has been noted that acacia species recover well from frequent cuttings (Ncube *et al*., 2018). The nutritional value of tannin-rich forages like acacia is largely determined by their tannin content (Mlambo *et al.,* 2009). Studies have shown that acacia leaves are rich in crude protein, minerals, and fatty acids, making them an excellent protein supplement for livestock (Ngwa *et al*., 2002; Mapiye *et al*., 2011). The crude protein in acacia leaves is particularly beneficial to ruminants during the dry season (Marume *et al.,* 2012). Acacia leaves are also characterized by relatively low detergent fiber, suggesting a high feeding value (Mokoboki *et al*., 2005; Mapiye *et al*., 2011). This study investigated the proximate composition, mineral content, and amino acid profile of *Acacia nilotica* leaves, identified as a promising alternative feed source for ruminants in Telengana.

Materials and Methods

Leaves of *Acacia nilotica* were collected from different locations near the College of Veterinary Science in Hyderabad (Telengana, India). The collected leaves were dried separately in hot air oven at 100 °C, ground to pass a 2 mm sieve in Willey mill and saved in polythene bags for further analysis. Proximate analysis, amino acid assessment and mineral estimation were carried out at the Animal Nutrition Lab of the College. The proximate composition of the *Acacia nilotica* leaves was determined using the standard methods outlined by the AOAC (2012). Neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) were measured using the methods described by Van Soest *et al.* (1991).

The mineral analysis was conducted using Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES). A 1 g of the dried powdered sample was transferred into a microwave digestion vessel, and 9 mL of concentrated nitric acid (HNO_3) and 1 mL of hydrogen peroxide (H_2O_2) were added. The sample was digested following standardized procedures. After digestion, the vessel was removed and allowed to cool to room temperature. The resulting digestate was filtered through Whatman filter paper No. 42, and the filtrate was quantitatively transferred into a 100 mL volumetric flask. The solution was then diluted to volume with Millipore water. Standard solutions for calibration were prepared by serial dilution of a 1000 µg/g stock standard solution with 1% nitric acid (HNO_3). Sample analyses were performed in triplicates, and the average of the triplicate measurements was taken.

Amino acid analysis was performed on leaf samples using High-Performance Liquid Chromatography (HPLC). Approximately 0.1 g of the sample was weighed and placed into a closed test tube. To this, 5 mL of 6N hydrochloric acid (HCl) was added, and the mixture was homogenized using a vortex mixer. The test tube was then purged with nitrogen gas to maintain an inert atmosphere. The sample was incubated in an oven at 110°C for 22 h. After incubation, the sample was allowed to cool, and the contents were transferred to a 50 mL volumetric flask and diluted to the mark with distilled water. The solution was then filtered through a 0.45 µm filter membrane. A 500 µL aliquot of the filtrate was mixed with 40 µL of acetic acid-borate buffer (AABA) and 460 µL of distilled water. From this mixture, 10 µL was transferred and reacted with 70 µL of AccQ-fluor borate reagent. The resulting solution was homogenized and allowed to stand for 1 min before being incubated at 55°C for 10 min. Finally, 5 µL of the prepared sample solution was injected into the HPLC column for analysis.

Results and Discussion

Proximate Composition

Proximate composition of *Acacia nilotica* tree leaves is presented in Table 1. It was observed from the result that the dry matter was high in *Acacia nilotica* (91.09%) which was comparable to the DM% of *Acacia saligna* (92.05%) and higher compared to *A. reficiens* and *A. Senegal* (87.8%) (Abd El-Galil *et al.* (2018). Organic matter content was also high (93.99%), indicating a low ash content (6%) comparable to the OM content (92%) reported by Cheema *et al*. (2011). The greater content of CP observed in *Acacia nilotica* (17.69%) is attributed to acacia leaves, which have an appreciable potential as protein source in ruminant feeding. The observed CP content was higher than the 13.2% reported for *A. nilotica* by Cheema *et al.* (2011) and the 16.62% for *Acacia etbaica* leaves reported by Abdalla and Ahmad (2023). The crude fiber and nitrogen-free extract contents in *Acacia nilotica* were 9.57% and 63.12%, respectively. Cell wall analysis, using detergent extraction, is an effective method for predicting the nutritional value of fibrous feed resources. Because voluntary dry matter intake and dry matter digestibility are dependent on cell wall constituents, especially NDF (37.15%) and lignin. *Acacia nilotica* leaves were found to contain low acid detergent fibre (17.97%), which indicates a high feeding value (Mokoboki *et al*., 2005; Mapiye *et al*., 2011). The value of the crude fat in *Acacia nilotica* leaves (3.60%, Table 1) was low compared with the leaves of *A. ataxacantha* (13.24%) reported by Daben *et al*. (2015).

Table 1: Proximate analysis and Van Soest analysis of the *Acacia nilotica* leaf meal

Parameter	Values (%)
Dry matter	91.09
Organic matter	93.99
Crude protein	17.69
Crude fat	3.60
Crude fiber	9.57
Total ash	6.00
Nitrogen free extract	63.12
NDF	37.15
ADF	17.97
ADL	15.85

*Each value is the average of duplicate observations

Mineral Composition

The results of macro-micro minerals and heavy metal analysis of the *Acacia nilotica* leaves are presented in Table 2. The mineral analysis showed higher concentration of calcium (1.26%), which is used for bone formation, followed by potassium (0.96%), sulphur (0.32%), followed by concentration of Mg (0.18%), P (0.16%), and lowest concentration of chlorine (0.05%). These levels were comparable to the concentrations of Ca (3.80%), K (1.10%), being the highest, and Na (0.15%) being the least reported by Cheema *et al*. (2011), but were quite lower than the concentrations of Ca (7.17%), K (9.18%) and P (0.95%) reported in *A. mearnsii* by Uushona *et al*. (2021). The mineral analysis data of the acacia leaves reported by Gebeyew (2015) showed high concentration of calcium and least concentration of magnesium among macro minerals. Ruminant can tolerate Ca:P ratio as wide as 7:1. Potassium is required for normal retention of protein during growth. Magnesium supports normal growth, while phosphorus is essential for bone formation.

Table 2: Macro-micro minerals and heavy metal analysis of the *Acacia nilotica* leaf meal

Minerals	Element	Concentration*
Macro-minerals (%)	Calcium	1.25
	Phosphorus	0.16
	Sulphur	0.32
	Magnesium	0.18
	Potassium	0.96
	Chlorine	0.05
Micro-minerals (ppm)	Cu	26.23
	Fe	408.5
	Zn	34.68
	Mn	39.45
	Co	0.36
	Cr	12.7
	Se	2.11
	Ni	8.78
	B	28.8
	Li	2.68
Heavy (Toxic) metal (ppm)	Pb	3.97
	Cd	0.1
	As	0.13

*Means of 9 observations each

The trace mineral analysis of the *Acacia nilotica* leaves showed higher concentrations (ppm) of Fe (408.5), Mn (39.45), Zn (34.68), B (28.8), and Cu (26.23). Fe is an essential trace element for haemoglobin synthesis, normal functioning of central nervous system and oxidation of carbohydrate, protein and fats. Zn and Mn are useful for vitamins stabilization. The concentration (ppm) of Cr (12.7), Ni (8.78), Li (2.68), Se (2.11), and Co (0.36) were lower in *Acacia nilotica* leaves among trace minerals studied (Table 2). These findings varied with the works of Gebeyew (2015), which showed the higher concentration on DM basis of Cu (237.9 mg/kg), followed by Fe (212.9 mg/kg), Mn (111 mg/kg), Mo (51 mg/kg), and lower concentrations of Se (16.1 mg/kg), Zn (6.6 mg/kg), Co (3.29 mg/kg) in leaves of *A. reficiencs*, while Uushona *et al.* (2021) showed higher concentration of Zn (16824 mg/kg), Cu (8594 mg/kg) and very low concentration of Se (58 mg/kg), Fe (0.21 mg/kg), Mn (0.11 mg/kg) in leaves of *A. mearnsii*. The results of the heavy metal analysis showed the concentrations of Pb (3.97 ppm), Cd (0.1 ppm), and As (0.13 ppm) (Table 2), while the studies conducted by Abdalla and Ahmad (2023) showed somewhat higher concentration of Pb (0.626 ppm) in the leaves of *Acacia etbaica*.

The variations in the mineral profiles of acacia leaves are mainly due to the availability of minerals in the soil and ability of uptake of minerals by the plant. As the age and size of the plants increase, the relative importance of the evapo-transpiration rate, particularly for the translocation of mineral elements increases. Higher mineral contents of *Acacia nilotica* plants species in this study further provoke their use a good alternative for animal feed.

Amino Acid Composition

The *Acacia nilotica* leaves sample analysis (Table 3) showed reasonably higher concentration of glutamic acid (1.736%), aspartic acid (1.681%), leucine (1.373%), lysine (1.01%), alanine (0.961%), arginine (0.957%), valine (0.945%), phenylalanine (0.895%), proline (0.885%), and glycine (0.818%). The glutamate/glutamic acid is helpful in improving intestinal health and whole body growth in animals (Fan *et al.,* 2023). Leucine has been shown to benefit lipid metabolism, insulin sensitivity, milk production, muscle growth and can be used as strategy for preventing and treating metabolic diseases (Rehman *et al.,* 2023). Moderate concentrations of isoleucine (0.781%), serine (0.729%), threonine (0.725%), and low concentrations of histidine (0.399%), methionine (0.298%) and cystine (0.195%) were observed in the present study (Table 3). Data showed that cystine was the first limiting essential amino acid, while methionine was the second limiting amino acid.

Table 3: Amino acid analysis of the *Acacia nilotica* leaf meal

Parameter	Content (% as is)	Content (% DMS)*
Dry matter	89.53	-
CP	16.94	16.65
Methionine	0.298	0.293
Cystine	0.195	0.192
Methionine + Cystine	0.493	0.485
Lysine	1.01	0.993
Threonine	0.725	0.713
Arginine	0.957	0.941
Isoleucine	0.781	0.768
Leucine	1.373	1.35

Valine	0.945	0.929
Histidine	0.399	0.392
Phenylalanine	0.895	0.88
Glycine	0.818	0.804
Serine	0.729	0.717
Proline	0.885	0.87
Alanine	0.961	0.945
Aspartic acid	1.681	1.652
Glutamic acid	1.736	1.706
NH3	0.301	0.296
Total including NH3	14.689	14.438
Total without NH3	14.388	14.142

*DMS: Figures standardized to dry matter content of 88%, CP = Crude protein, based on Dumas combustion method (CP factor 6.25)

A study conducted by Uushona *et al*. (2021) showed the similar results with higher concentration of aspartate, arginine, proline, glutamine, leucine, phenylalanine and lysine in leaves of *A. mearnsii*. Abd El-Galil *et al*. (2018) showed reasonable concentrations of leucine, valine and arginine, and methionine was the first limiting, while lysine was the second limiting amino acid in leaves of *Acacia saligna*. They further recommended up to 8% *Acacia saligna* leaf meal level in Mamourah growing hen's diets without any negative effects on their performance. Greater lysine content observed in *A. mearnsii* leaf-meals may be attributed to its higher proline content that also protects cellular structures, stability and integrity of proteins and increase enzyme activity (Karmous and Verma, 2020).

Conclusion

The study highlights the potential of *Acacia nilotica* leaf meal as an alternative feed for ruminants, showcasing their high nutritional value. With a dry matter content of 90.09%, organic matter of 93.99%, and crude protein of 17.69%. *Acacia nilotica* leaves are an excellent protein source, especially during the dry season. Their rich mineral profile, including calcium (1.26%) and potassium (0.96%), supports bone health and protein retention, while trace minerals like iron (408.5 ppm) and zinc (34.68 ppm) further enhance their value. Low levels of heavy metals ensure safety for consumption. The balanced amino acid profile, especially glutamic acid, leucine, and lysine, supports growth, milk production, and overall health. Acacia's ability to grow in harsh conditions makes it sustainable and viable alternative forage, however further studies are needed to evaluate its long-term effects on ruminant productivity.

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References

Abd El-Galil, K., Hassan, M.M., El-Soud, K.A., Abd El-Dayem, A.A., & Salem, F.M. (2018). Utilization of *Acacia saligna* leaf meal as a non-traditional feedstuff by local growing hens under desert conditions. *Egyptian Journal of Nutrition and Feeds*, *22*(1), 211-217.

Abdalla, A., & Ahmed, A.A. (2023). Proximate analysis, mineral contents, and GC-MS analysis of leaves, twigs, and thorns of *Acacia Etbaica Schweinf*. *Journal of Medicinal Plants Studies, 11*(2), 8-11.

AOAC (2012). *Official Methods of Analysis of the Analytical Chemist International*. 18th ed. Gathersburg, MD, USA.

Cheema, U.B., Sultan, J.I., Javaid, A., Akhtar, P., & Shahid, M. (2011). Chemical composition, mineral profile and in situ digestion kinetics of fodder leaves of four native trees. *Pakistan Journal of Botany*, *43*(1), 397-404.

Daben, J.M., Dashak, D.A., Praise, O., Ogbole, E., & Agba, M.A. (2017). Assessment of the proximate and mineral compositions of *Acacia ataxacantha* leaves. *International Journal of Science and Research, 6*(5), 899-903.

Dagba, B.I., & Harris, B.J. (2014). Studies on Acacias in the Zaria area of Kaduna State Nigeria. *International Journal of Science and Research*, *3*(1), 449-452.

Dhillon, R.S., Beniwal, R.S., Satpal, M.J., & Kumari, S. (2023). Tree fodder for nutritional security and sustainable feeding of livestock - A review. *Forage Research*, *49*(1), 21-28.

Fan, L., Liu, X., Deng, Y., & Zheng, X. (2023). Preparation of glutamine-enriched fermented feed from corn gluten meal and its functionality evaluation. *Foods*, *12*(23), 4336.

Gebeyew, K. (2015). Review on the nutritive value of some selected Acacia species for livestock production in dryland areas. *Advances in Dairy Research*, *3*(2), 139

Hassen, A., Ebro, A., Kurtu, M., & Treydte, A.C. (2010). Livestock feed resources utilization and management as influenced by altitude in the Central Highlands of Ethiopia. *Livestock Research for Rural Development*, *22,* 229

IGFRI Vision (2050). Indian Grassland and Fodder Research Institute, Jhansi (UP), India, p. 40.

Karmous, I., & Verma, S.K. (2020). How effective are stress-associated proteins in augmenting thermotolerance. *Heat Stress Tolerance in Plants: Physiological, Molecular and Genetic Perspectives*, p.33-46, Wiley Online Books. https://doi.org/10.1002/9781119432401.ch3

Mapiye, C., Chimonyo, M., Marufu, M.C., &Dzama, K. (2011). Utility of *Acacia karroo* for beef production in Southern African smallholder farming systems: A review. *Animal Feed Science and Technology*, *164*(3-4), 135-146.

Marume, U., Chimonyo, M., &Dzama, K. (2012). Influence of dietary supplementation with *Acacia karroo* on experimental haemonchosis in indigenous Xhosa lop-eared goats of South Africa. *Livestock Science*, *144*(1-2), 132-139.

Mashamaite, L., Ng'ambi, J.W., Norris, D., Ndlovu, L.R., & Mbajiorgu, C.A. (2009). Relationship between tannin contents and short-term biological responses in male rabbits supplemented with leaves of different acacia tree species grown in Limpopo province of South Africa. *Livestock Research for Rural Development*, *21*(7), 109 http://www.lrrd.org/lrrd21/7/mash21109.htm

Mathobela, M.M (2018). Effect of *Acacia karroo* leaf meal on methane production and productivity of boar goats. *M.Sc. Thesis* (unpublished). University of Limpopo, South Africa.

Mlambo, V., Mould, F.L., Smith, T., Owen, E., Sikosana, J.L.N., & Mueller-Harvey, I. (2009). *In vitro* biological activity of tannins from Acacia and other tree fruits: Correlations with colorimetric and gravimetric phenolic assays. *South African Journal of Animal Science*, *39*(2), 131-143

Mokoboki, H.K., Ndlovu, L.R., Ng'ambi, J.W., Malatje, M.M., & Nikolova, R.V. (2005). Nutritive value of Acacia tree foliages growing in the Limpopo Province of South Africa. *South African Journal of Animal Science*, *35*(4), 221-228.

Ncube, S., Halimani, T.E., Chikosi, E.V.I., & Saidi, P.T. (2018). Effect of *Acacia angustissima* leaf meal on performance, yield of carcass components and meat quality of broilers. *South African Journal of Animal Science*, *48*(2), 271-283.

Ngwa, A.T., Nsahlai, I.V., & Bonsi, M.L.K. (2002). The rumen digestion of dry matter, nitrogen and cell wall constituents of the pods of *Leucaena leucocephala* and some Acacia species. *Journal of the Science of Food and Agriculture*, *82*(1), 98-106.

Niderkorn, V., & Baumont, R. (2009). Associative effects between forages on feed intake and digestion in ruminants. *Animal*, *3*(7), 951-960.

Rehman, S.U., Ali, R., Zhang, H., Zafar, M.H., & Wang, M. (2023). Research progress in the role and mechanism of leucine in regulating animal growth and development. *Frontiers in Physiology*, *14*, 1252089.

Tsegaye, D., Balehgn, M., Gebrehiwot, K., Haile, M., Gebresamuel, G., & Aynekulu, E. (2007). The role of garsa (*Dobera glabra*) for household food security at times of food shortage in Abaala Wereda, North Afar: Ecological adaptation and socio-economic value: a study from Ethiopia. *DCG Report* No. 49.

Uushona, T., Chikwanha, O.C., Tayengwa, T., Katiyatiya, C.L.F., Strydom, P.E., & Mapiye, C. (2021). Nutraceutical and preservative potential of *Acacia mearnsii* and *Acacia dealbata* leaves for ruminant production and product quality enhancement. *The Journal of Agricultural Science*, *159*(9-10), 743-756.

Van Soest, P.V., Robertson, J.B., & Lewis, B.A. (1991). Methods for dietary fiber, neutral detergent fiber, and nonstarch polysaccharides in relation to animal nutrition. *Journal of Dairy Science, 74*(10), 3583-3597.