**Nutritional Evaluation of Guava (Psidium guajava) Leaves as a Sustainable Feed Resource for Livestock**

**ABSTRACT**

The increasing livestock population in India has led to a significant feed deficit, highlighting the need for alternative feed resources. Guava (*Psidium guajava*) leaves, which are rich in essential nutrients, offer a potential non-conventional feed resource. This study evaluates the proximate composition, mineral profile, and amino acid content of guava leaves to determine their nutritional suitability for livestock. The analysis revealed a high organic matter content (93.31%) and a moderate crude protein level (12.7%), indicating their potential as a protein source. Additionally, guava leaves contain substantial levels of essential minerals such as calcium (166.93 ppm), potassium (126.3 ppm), and iron (241.81 ppm), which are vital for animal health. The amino acid profile further supports the nutritional benefits, with high concentrations of glutamic acid (1.002%) and aspartic acid (0.96%). These findings suggest that guava leaves could serve as a valuable supplementary feed ingredient to enhance animal nutrition and overall productivity.

***KEYWORDS:*** *Livestock feed deficit, Alternative feed resources, Guava leaves (Psidium guajava)*, *Supplementary feed* , *Livestock productivity*

1. **INTRODUCTION**

India holds the top position globally in terms of total livestock population. The latest data shows that there has been an increase of 4.6% in livestock since the last census undertaken in 2012. Nonetheless, this rise has not resulted in more feeds or fodders thereby causing a deficit in essential resources for animals. Total area under fodder cultivation is around 8.4 mha (5.23%) which is almost static for the past two decades (11). At present, India faces a net deficit of 35.6% green fodder (GF), 10.95% dry crop residues and 44% concentrate feeds. The deficit may further rise due to consistent growth of livestock population at the rate of 1.23% in near future (13). The situation worsens mostly in rainfall deficit states viz. Gujarat, Rajasthan, Karnataka, Madhya Pradesh, Andhra Pradesh, and Maharashtra. To secure the wellbeing and productivity of herds, it is important to address this problem. Ways to solve it encompass better feed production methods, use of non conventional feed resources to ensure sustainable animal production.one such way is use of tree leaves as feed resource for animals.

Guava (Psidium guajava) is a small tropical tree that grows up to 35 feet tall; it is widely grown for its fruit in tropics. It is a member of the Myrtaceae family, with about 133 genera and more than 3800 species. Guava leaves contain high levels of Vitamin C, Iron, Calcium, and phosphorous (19). The antioxidants in the guava foliage include essential oils, polysaccharides, pectins, minerals, vitamins, triterpenoid acid enzymes and alkaloids, steroids, glycosides, tannins, flavonoids and saponins, which can have potential use in functional feeds to improve the health of animals (15,21). Thomas et al;2017(19) reported 16.8 mg protein/100g and 8 mg amino acids/100g in guava leaves as estimated according to Lowry’s and ninhydrin methods, respectively. The higher concentrations of Mg, Na, S, Mn, and B in guava leaves makes them a highly suitable choice for human nutrition and also as an animal feed to prevent micronutrient deficiency (3). Guava is one of the important commercial fruits in India. It is the fourth most important fruit after mango, banana and citrus. The area under guava cultivation in India increased by 227.6% from 94 thousand ha. in 1991-92 to 308.1 thousand ha. in 2020-21 whereas the production increased by 318.18% from 11 lakh tones to 46 lakh tonnes. Major guava producing states include Uttar Pradesh, Bihar, West Bengal, Maharashtra, Chhattisgarh, Tamil Nadu, Karnataka, Madhya Pradesh, Gujarat and Andhra Pradesh. (17).

1. **MATERIALS AND METHODS**

Leaves were gathered from locations near the College of Veterinary Science in Rajendranagar. Healthy branches with leaves were chosen from all four directions for each plant. These collected leaves were cleaned with water to remove dust and dried in the sun. Ground into powder and sieved to fine powder for additional examination. Proximate analysis, amino acid assessment and mineral estimation were carried out at the Animal Nutrition Lab situated in the College of Veterinary Science at Rajendranagar.

 The proximate composition of the neem leaves was determined using the standard methods outlined by the Association of Official Analytical Chemists. the percentage moisture content was calculated as described in AOAC (2012). Dry matter (DM) content was determined by drying the sample at 105 °C in forced air oven till the constant weight. Ash content was measured after igniting sample in a muffle furnace at 55 °C for 4 hours (h). Crude protein (CP) (N × 6.25) was determined by Kjeldahl method. 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(20). The results are presented in Table 1.

 Mineral analysis was done using ICP-OES (Inductively coupled plasma-optical emission spectroscopy) (14). 1g of the dried powdered sample was taken in the microwave digestion vessel. 9ml of HNO3and 1ml of H2O2 is added to the sample and digestion of the sample was done as per standard. The vessel is then taken out and cooled to room temperature. The digested solution is then filtered through whatmann filter paper No.42 and the filtered solution is transferred to the 100ml volumetric flask and diluted with Millipore water. Standard solutions of the elements are prepared using the stock standard solution of 1000µg/g by dilution with 1% HNO3. Analysis of samples was done in triplicates and the given data in the table 2 is average of the triplicate measures.

Amino Acid analysis was done using Samples of guava leaves by using HPLC, weighing up to 0.1 g, were placed in a closed test tube, followed by the addition of 5 ml of 6 N hydrochloric acid (HCl). The mixture was then homogenized using a vortex mixer. The test tube was filled with nitrogen gas to create an inert atmosphere. Following this, the sample was incubated in an oven at 110 °C for 22 hours. After

cooling, the contents were transferred to a 50 ml volumetric flask and diluted with aquabidest to the calibration mark. The solution was then filtered through a 0.45 μm filter membrane. A volume of 500 µl of the filtrate was pipetted and mixed with 40 µl of AABA (acetic acid-borate buffer) and 460 µl of aquabidest. From this mixture, 10 µl was taken and combined with 70 µl of AccQ-Fluor Borat reagent. The resulting solution was homogenized and allowed to stand for one minute before being incubated at 55 °C for 10 minutes. Finally, 5 µl of the prepared sample solution was injected into the HPLC column for analysis.

1. **RESULTS AND DISCUSSION:**

**3.1.Proximate Analysis:**

The proximate analysis of guava leaves revealed a high organic matter content (93.31%) and a moderate crude protein level (12.7%). These findings align with previous studies, which have reported similar protein levels in guava leaves (7,12). The high nitrogen-free extract (61.49%) suggests that guava leaves are a rich source of carbohydrates, making them a potential energy source for livestock. However, the crude fiber content (17.49%) is moderate, which may limit their use as a primary feed resource but makes them suitable as a supplementary feed ingredient. The low crude fat content (2.5%) is consistent with the low-fat nature of guava leaves, as reported by Abdul et al.,2016(1) The high carbohydrate and moderate protein content make guava leaves a promising energy and protein supplement for livestock, particularly in regions where conventional feed resources are scarce (4).

**3.2.Mineral Profile:**

The mineral analysis indicated that guava leaves are rich in essential minerals such as calcium (166.93 ppm), potassium (126.3 ppm), and iron (241.81 ppm). These minerals are crucial for bone development, muscle function, and haemoglobin synthesis in animals (12,19). The moderate levels of zinc (24.33 ppm), copper (21.48 ppm), and selenium (1.35 ppm) further enhance the nutritional value of guava leaves, as these micronutrients play vital roles in immune function and antioxidant activity (18). The low concentrations of toxic minerals like lead (3.35 ppm) and cadmium (0.05 ppm) suggest that guava leaves are safe for animal consumption, as these levels are well below the toxic thresholds for livestock (3).

**3.3.Amino Acid Profile:**

The amino acid analysis revealed that guava leaves contain high levels of glutamic acid (1.002%) and aspartic acid (0.96%), which are important for intestinal health and growth in animals (6). Leucine (0.839%), known for its role in muscle growth and milk production, was also present in significant amounts (16). Moderate levels of lysine (0.589%), arginine (0.551%), and proline (0.54%) further support the potential of guava leaves as a feed resource for improving protein synthesis, immune function, and stress tolerance in livestock (22,25). The low concentrations of methionine (0.206%) and cystine (0.1%) suggest that guava leaves may need to be supplemented with other protein sources to meet the sulfur-containing amino acid requirements of livestock (28).

|  |
| --- |
| **Table 1**: Proximate analysis and van soest analysis of the guava leaves |
| **Parameter**  | **Values (%)** |
| Dry matter  | 91.03 |
| Organic matter  | 93.31 |
| Crude Protein  | 12.70 |
| Crude Fat  | 2.5 |
| Crude Fiber  | 17.485 |
| Total Ash  | 6.68 |
| Nitrogen Free Extract  | 61.49 |
| NDF  | 56.08 |
| ADF  | 44.72 |
| ADL | 38.38 |
| AIA | 2.225 |

|  |
| --- |
| **Table 2:** Micromineral profile of Leaf samples |
| **Mineral** | **Conc.(ppm)** |
| Cu | 21.48 |
| Fe | 241.81 |
| Zn | 24.33 |
| Mn | 42.43 |
| Co | 0.55 |
| Cr | 12.43 |
| Li | 2.61 |
| Se | 1.35 |

|  |
| --- |
| **Table 3**: Macro mineral profile of leaf samples |
| **Mineral** | **Conc.(ppm)** |
| Ca | 166.93 |
| P | 12.24 |
| S | 35.13 |
| Mn | 38.32 |
| K | 126.3 |
| Al | 1.77 |
| **Table 4:** Toxic mineral profile of leaf samples |
| **Mineral** | **Conc.(ppm)** |
| Pb | 3.35 |
| Cd | 0.05 |
| As |  |
| Table 5: **Occasionally beneficial minerals of leaf samples** |
| **Mineral** | **Conc.(ppm)** |
| Ni | 7.5 |
| B | 46.88 |
| \*Each value is the average of nine observations |

|  |
| --- |
| **TABLE 6 : Amino Acid profile** |
| **Parameter** | **Content (% as is)** | **Content (%)\*** |
| Dry matter | 89.99 |  |
| CP | 10.3 | 10.07 |
| Methionine | 0.206 | 0.201 |
| Cystine | 0.1 | 0.098 |
| Methionine + Cystine | 0.306 | 0.299 |
| Lysine | 0.589 | 0.576 |
| Threonine | 0.439 | 0.429 |
| Arginine | 0.551 | 0.539 |
| Isoleucine | 0.443 | 0.433 |
| Leucine | 0.839 | 0.82 |
| Valine | 0.549 | 0.537 |
| Histidine | 0.23 | 0.225 |
| Phenylalanine | 0.546 | 0.534 |
| Glycine | 0.527 | 0.515 |
| Serine | 0.433 | 0.423 |
| Proline | 0.54 | 0.528 |
| Alanine | 0.577 | 0.564 |
| Aspartic acid | 0.96 | 0.939 |
| Glutamic acid | 1.002 | 0.98 |
| \* DMS: Figures standardized to a dry matter content of 88%, CP = Crude protein, based on Dumas combustion method (CP factor 6.25) |

**Comparative Analysis with Other Feed Resources:**

When compared to conventional feed resources like alfalfa and soybean meal, guava leaves offer a unique combination of nutrients. While their protein content (12.7%) is lower than that of soybean meal (40-50%), their rich mineral profile and balanced amino acid composition make them a valuable supplement for addressing micronutrient deficiencies in livestock (7,12). For example, the calcium content in guava leaves (166.93 ppm) is significantly higher than that in alfalfa (15-20 ppm), making them a suitable supplement for improving bone health in animals (3). Additionally, the widespread availability of guava leaves in tropical regions makes them a cost-effective alternative to traditional feed ingredients, particularly in areas facing feed shortages (11).

**Practical Implications and Future Research:**

The findings of this study suggest that guava leaves could be incorporated into livestock diets as a sustainable feed resource. Their high organic matter and nitrogen-free extract content make them a valuable energy source, while their moderate protein and rich mineral profile enhance their nutritional value. However, further research is needed to evaluate their digestibility and potential antinutritional factors, such as tannins and saponins, which may limit their utilization in animal diets (15). Long-term feeding trials are also necessary to assess the impact of guava leaves on animal health, productivity, and reproductive performance. Future studies should explore the optimal inclusion levels of guava leaves in animal diets and investigate their effects on milk production, weight gain, and metabolic functions (10).

1. **CONCLUSION:**

The results of this study demonstrate that guava (*Psidium guajava*) leaves possess a favorable nutritional composition, making them a promising alternative feed resource for livestock. The high organic matter and nitrogen-free extract content suggest that these leaves can contribute to energy supply, while their moderate protein content and rich mineral profile enhance their nutritional value. The amino acid composition, particularly the presence of glutamic acid and lysine, underscores their potential to support growth, metabolic functions, and overall health in animals. Given their widespread availability and nutritional benefits, guava leaves could be incorporated into animal diets as a sustainable feed resource. Further research on digestibility and long-term feeding trials is recommended to optimize their inclusion in livestock feeding programs.

1. **REFERENCES:**
2. Abdul, A., et al. (2016). Proximate Composition of Guava Leaves. *Journal of Innovative Research and Review*. Retrieved from [Cibtech](https://www.cibtech.org/J-Innovative-Research-Review/Publications/2016/VOL-4-NO-2/01-JIRR-001-%28JUNE%29ABDUL-PROXIMATE.pdf%22%20%5Ct%20%22_blank).
3. Adefagha, S. and Obah, G. (2011). Water extractable phytochemicals from some Nigeria spices inhibit Fe2+ induced lipid peroxidation in rat’s brain in vitro. Food Processing and Technology, 1(2): 2-6.
4. Adrian, J.A.L.; Arancon, N.Q.; Mathews, B.W.; Carpenter, J.R. Mineral composition and soil-plant relationships for common guava (Psidium guajava L.) and yellow strawberry guava (Psidium cattleianum var. Lucidum) tree parts and fruits. Commun. Soil Sci. Plant Anal. 2015, 46, 1960–1979. [CrossRef]
5. Alabi, A. A., Luky, O.O. and Kate, E. I. (2010). Phytochemical, proximate and metal content analysis of leaves of Psidium guajava. International Journal of Health Research, 3(4): 217.
6. AOAC. Official Methods of Analysis of the Analytical Chemist International, 18th ed. Gathersburg, MD, USA: AOAC; 2012.
7. Fan L, Liu X, Deng Y, Zheng X. Preparation of glutamine-enriched fermented feed from corn gluten meal and its functionality evaluation. Foods. 2023 Dec 1;12(23):4336.
8. Feedipedia. (2015). Guava Leaves.
9. Gbaguidi GT, Saricicek BZ. 2021. Availability of some tropical plants as alternative roughage source in ruminant feeding. BSJ Agri, 4(3): 107-111
10. Jassal, K.; Kaushal, S. Phytochemical and antioxidant screening of guava (Psidium guajava) leaf essential oil. Agric. Res. J. 2019, 56, 528. [CrossRef]
11. Jiang, L.R., Qin, Y., Nong, J.L. and An, H., 2021. Network pharmacology analysis of pharmacological mechanisms underlying the anti-type 2 diabetes mellitus effect of guava leaf. *Arabian Journal of Chemistry*, *14*(6), p.103143.
12. Koli, P. and Bhardwaj, N.R. 2018. Status and use of pesticides in forage crops in India. Journal of Pesticide Science, 43: 225-232.
13. Kumar M, Tomar M, Amarowicz R, Saurabh V, Nair MS, Maheshwari C, Sasi M, Prajapati U, Hasan M, Singh S, Changan S, Prajapat RK, Berwal MK, Satankar V. Guava (*Psidium guajava* L.) Leaves: Nutritional Composition, Phytochemical Profile, and Health-Promoting Bioactivities. Foods. 2021 Apr 1;10(4):752. doi: 10.3390/foods10040752. PMID: 33916183; PMCID: PMC8066327.
14. Kumar, R. 2016. Fodder production-status, constraints, strategies. https://www.biotecharticles.com/ Agriculture-Article/Fodder-Production-Status-constraints-strategies-3563.html.
15. Markandeya, Anil & Firke, Narayan & Pingale, Suresh & Salunke, Sunita. (2013). Quantitative elemental analysis of Celocia argentea leaves by ICP-OES technique using various digestion methods. International Journal of Chemical and Analytical Science. 4. 10.1016/j.ijcas.2013.08.003.
16. **Naseer S, Hussain S, Naeem N, Pervaiz M and Rahman M 2018**The phytochemistry and medicinal value of Psidium guajava (guava). Clin. Phytos. 4, 32. <https://doi.org/10.1186/s40816-018-0093>
17. Rehman SU, Ali R, Zhang H, Zafar MH, Wang M. Research progress in the role and mechanism of leucine in regulating animal growth and development. Front Physiol. 2023 Nov 17; 14:1252089.
18. Saxena, M. and Gandhi, C.P., 2014. *Indian horticulture database-2014*. National Horticulture Borad.76-83
19. Shabbir, M., et al. (2023). Nutritional Composition, Mineral Profiling, In Vitro Antioxidant, Antibacterial and Enzyme Inhibitory Properties of Selected Indian Guava Cultivars Leaf Extract. *Pharmaceuticals* 2023, 16, 1636. Retrieved from [MDPI](https://www.mdpi.com/1424-8247/16/12/1636).
20. Thomas, Lintu & Ab, Lasyaja & T, Anitha & M, Suganya & P, Gayathri & S, Chithra. (2017). Biochemical and mineral analysis of the undervalued leaves – Psidium guajava L. 2. 2455-4227.
21. Van Soest PV, Robertson JB, Lewis BA. Methods for dietary fiber, neutral detergent fiber, and non-starch polysaccharides in relation to animal nutrition. Journal of dairy science. 1991 Oct 1;74(10):3583-3597.
22. **Venkatachalam R N, Singh K and Marar T 2012**Phytochemical screening in vitro antioxidant activity of Psidium guajava. Free Radic. and Antiox. 2, 31–36. <https://doi.org/10.5530/ax.2012.2.7>
23. Wu, G., Bazer, F.W., Davis, T.A., Kim, S.W., Li, P., Marc Rhoads, J., Carey Satterfield, M., Smith, S.B., Spencer, T.E. and Yin, Y., 2009. Arginine metabolism and nutrition in growth, health and disease. *Amino acids*, *37*, pp.153-168.
24. Carletti, M.Z. and Christenson, L.K., 2009. MicroRNA in the ovary and female reproductive tract. *Journal of animal science*, *87*(suppl\_14), pp.E29-E38.
25. Li, P., Yin, Y.L., Li, D., Kim, S.W. and Wu, G., 2007. Amino acids and immune function. *British journal of nutrition*, *98*(2), pp.237-252
26. Phang, J.M., Liu, W.E.I. and Zabirnyk, O., 2010. Proline metabolism and microenvironmental stress. *Annual review of nutrition*, *30*(1), pp.441-463.
27. **Szabados, L., & Savouré, A. (2010).** Proline: A multifunctional amino acid. Trends in Plant Science, 15(2), 89-97.
28. **Kidd, M. T., Ferket, P. R., & Garlich, J. D. (2008).** Nutritional and osmoregulatory functions of betaine. World's Poultry Science Journal, 64(3), 429-440.
29. **Brosnan, J. T., & Brosnan, M. E. (2006).** The sulphur-containing amino acids: An overview. Journal of Nutrition, 136(6), 1636S-1640S.