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Exploring the Nutritional Value of Different Tree Leaf Meal Combinations in Himachal Pradesh

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***Abstract*:** Most farmers in Himachal Pradesh use the foliage from important plant species such as *Leucaena leucocephala*, *Acacia catechu* and *Albizia chinensis* to feed their livestock. The current study was conducted at Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan to assess the nutrient composition of various combinations of tree leaf meals. In September 2020, leaf samples from three different species: *Leucaena leucocephala*, *Acacia catechu* and *Albizia chinensis* were collected, sun-dried and various combinations of tree leaf meals were prepared by blending them in varying proportions. The proximate analysis of the tree leaf combinations indicated notable differences. The contents of crude fibre (CF), neutral detergent fibre (NDF) and acid detergent fibre (ADF) were significantly higher in the combination of *L. leucocephala* (1): *A. catechu* (1): *A. chinensis* (3). Conversely, in *L. leucocephala* (3): *A. catechu* (1): *A. chinensis* (1) compositions the content of Crude protein (CP), acid insoluble ash (AIA) and phosphorus (P).were significantly higher, mainly attributed to the higher proportion of *L. leucocephala*. The nutritional value of the tree leaf meal combination which consisted of a mixture of *L. leucocephala, A. catechu* and *A. chinensis* in a ratio of 3:1:1, had the highest nutritional value. This leaf meal combination has a higher concentration of crude protein and phosphorus and a minimum concentration of crude fibre, neutral detergent fibre and acid detergent fibre.

***Keywords*:** Tree leaf meals, *L. leucocephala*, *A. catechu*, *A. chinensis*, Livestock feeding

Livestock farming constitutes a primary source of livelihood in India's rural economy. Livestock production stands as a crucial pillar of rural livelihoods, contributing substantially to the socioeconomic landscape of the nation. Approximately 20.5 million individuals in India depend on livestock for their sustenance, highlighting its significance in supporting livelihoods. Moreover, the livestock sector contributes about 16 per cent of the overall income of small agricultural households, presenting its substantial economic contribution (Dash 2017). The livestock sector holds considerable importance in generating cash revenue through the processing of various products such as milk, butter, eggs, wool and others. However, livestock production is hampered mostly by the restricted availability of green fodder, especially during the dry season. In India, there is a significant deficit in concentrated feed ingredients, amounting to 44%, green fodder 35.6% and dry fodder, with a shortage of 10.95% and the projected demand for dry fodder by 2050 is expected to reach 1012 million tonnes, while the demand for green fodder is estimated to be 631 million tonnes (IFGRI Vision, 2050). Providing enough fodder to cattle during the lean period can be quite challenging. One strategy to overcome this shortage is to utilize underutilized feed resources like tree leaves. Fodder trees serve as vital sources of both protein and energy, crucial for maintaining animal health, promoting growth rates and enhancing milk and wool production. Tree stands out as one of the most dependable sources of fodder due to their extended rotation period. They play a crucial role in producing nutrient-rich fodder, especially during lean periods and can provide green fodder with a nutritional value equivalent to that of leguminous crops (Dhillon et al 2023). Tree leaves can also be processed into tree leaf meals, offering a concentrated form of nutrition that can be effectively utilized in animal feeding. In the Northwest Himalayas, the leaves of Leucaena, Acacia and Albizia are commonly utilized as tree fodders. However, there are limited studies available on their utilization in the form of tree leaf meals. Consequently, the purpose of this research was to assess the nutritional value of various combinations of tree leaf meals for their effective utilization in animal feeding.

MATERIAL AND METHODS

Study area: The present study was conducted at Dr Y.S. Parmar University of Horticulture and Forestry, located in Nauni, Solan-173230, Himachal Pradesh, in 2020-21. The sampling site is situated at an elevation of 1275 m above mean sea level in the mid-Himalayan zone of Himachal Pradesh. It falls within the coordinates of 30°50' 30" to 30°52' 0" N latitude and 77°08' 30" to 77°11' 30" E longitude, as indicated by Survey of Indian Toposheet number 53F/1.

Methodology adopted: To prepare tree leaf meal, 15 trees from each species (*Leucaena leucocephala*, *Acacia catechu*

and *Albizia chinensis*) were randomly chosen and pruned in September 2020. The leaves were then harvested from these trees and composite samples were gathered for evaluating the nutritional content of each species. The harvested foliage biomass was spread out on plastic sheets and exposed to sunlight for a period of four to five days to facilitate drying. The dry leaves were extracted from the plastic sheet on either the fifth or sixth day, placed in bags and stored in a dry and well-ventilated area, protected from direct sunlight. The leaf meal was prepared by making the different ratios of three species (*Leucaena leucocephala*, *Acacia catechu* and *Albizia chinensis*) in a total of ten different combinations. After mixing the leaf meals in various proportions, the samples were gathered for the assessment of proximate, Van Soest principles and mineral contents. The proximate principles i.e. dry matter (DM) (%), crude protein (CP) (%), ether extract (EE) (%), crude fibre (CF) (%), total ash (%), nitrogen free extract (NFE) (%) were estimated using the standard methods of AOAC (2000). The neutral detergent fibre (NDF%) and acid detergent fibre (ADF%) were determined by the standard method (Van Soest et al 1991). The ash content was assessed by incinerating samples at 560° C for 8 h in a muffle furnace. Following this, the ash from each sample underwent additional analysis for calcium and phosphorus using calorimetric and spectrophotometric procedures. The calcium (Ca) content was determined by using the flame photometer method, while phosphorus (P) content was analysed using the atomic absorption spectrophotometer method. The data was analysed by using OPSTAT statistical software, as described by Sheoran (2010).

RESULTS AND DISCUSSION

Nutritional evaluation of the species: The highest DM, EE, NFE, TA, and Ca were in *Acacia catechu*. The highest CF, NDF and ADF were in *Albizzia chinensis* and the highest CP, AIA, and P in *Leuceana leucocephala*. The lowest CP, NDF, ADF and P in *Acacia catechu*, lowest EE, NFE, TA, and AIA in *Albizzia chinensis* and the lowest DM, CF, and Ca in *Leuceana leucocephala* leaves (Table 1).

Nutritive value of different tree leaf meal combinations: The mean dry matter content of leaf meal combinations prepared from *L. leucocephala, A. catechu* and *A. chinensis* leaves in different ratios was 90.55 per cent. The DM per cent was statistically at par in all treatments. The DM decreased in the following order T10 > T4 > T1 > T7 > T5 > T3 > T9 > T6 > T2 > T8. Patra et al (2002) also observed a dry matter percentage of 90.33 per cent in leaf meal prepared from a mixture of *L. leucocephala, M. alba* and *A. indica* in a 2:1:1 ratio. Bairagi et al (2004) reported a dry matter content of 92.65 per cent in the nutritive evaluation of *L. leucocephala* leaf meal. The lower amounts of moisture required for the preservation of the leaf meal were evidenced by the larger DM values in the tree leaf meal. The higher moisture level could otherwise cause meals to deteriorate while being stored.

The mean CP content of leaf meal combinations prepared from *L. leucocephala, A. catechu* and *A. chinensis* leaves in various ratios was 16.11 per cent. The CP content in different tree leaf meals was in the following order i.e., T8 > T2 > T6 > T5 > T1 > T10 > T4 > T7 > T3 >T9, respectively. The mean CP was maximum in T8 (18.19 %) and minimum in T9 (14.48%). The highest CP content in T8 could be attributed to the higher proportions of *L. leucocephala* leaves in the leaf meal mixture. The decrease in the CP content in the treatment T9 prepared by mixing *L. leucocephala, A. catechu* and *A. chinensis* in the ratio of 1:3:1 is because the leaves of *A. catechu* contained lower CP content as compared to the other fodder tree species. Patra et al (2002) also recorded 23.13 per cent CP in the leaf meal prepared from a mixture of *L. leucocephala, Morus alba* and *Azadirachta indica* in a ratio of 2:1:1 and 15.9 per cent CP in leaf meal of *Acacia nilotica* as reported by Rubanza et al (2007).

The mean EE content of leaf meal combinations prepared from *L. leucocephala, A. catechu* and *A. chinensis* leaves in various ratios was 4.13 per cent. The mean EE content of the leaf meal sample was highest in T9 (4.52%) and lowest in T10 (3.57%). The EE content of the treatments decreased in the following order i.e. T9 > T5 > T2 > T3 > T8 > T1 > T7 > T4 > T6 > T10. Anbarasu et al (2004) reported 4.25 per cent EE content in leaf meal mixture was prepared by using *L. leucocephala, Morus alba* and *Tectona grandis* in a ratio of 2:1:1.

The crude fibre content in various leaf meal combinations ranged between 18.01 and 25.87 per cent with the highest CF in T10 (25.87%) and lowest in T8 (18.01). Adedeji et al

Table 1. Nutritional composition of fodder tree leaves used for making leaf meal

Tree species	DM (%)	CP (%)	EE (%)	CF (%)	NDF (%)	ADF (%)	NFE (%)	TA (%)	AIA (%)	Ca (%)	P (%)
Leuceana leucocephala	33.73^{c}	21.19^{a}	4.76^{b}	16.49^{c}	30.23^{b}	20.20^{b}	49.64^{b}	7.90^{a}	0.95^{a}	0.96^{c}	0.28^{a}
Acacia catechu	64.19^{a}	10.87^{c}	5.11^{a}	19.67^{b}	29.29^{c}	19.52^{c}	56.38^{a}	7.96^{a}	0.81^{b}	3.59^{a}	0.05^{c}
Albizia chinensis	47.09^{b}	13.56^{b}	2.35^{c}	35.25^{a}	39.08^{a}	23.44^{a}	43.16^{c}	5.66^{b}	0.62^{c}	2.07^{b}	0.13^{b}

Means with different superscripts within the column differ significantly ($p<0.05$)

(2013) and Ncube et al (2018) reported 13.85 and 13.00 per cent CF in the *L. leucocephala* and *Acacia angustissima* leaf meal, respectively. The mean NDF content of leaf meal combinations prepared from *L. leucocephala, A. catechu* and *A. chinensis* leaves in various ratios was 31.00 per cent. The highest NDF content was in T10 (33.49%) and the lowest NDF content was in T9 (29.72%). The lower NDF content in T9 is mainly due to the low NDF content in *A. catechu* leaf samples. Rubanza et al (2007) recorded 18.90 per cent NDF content in *Acacia nilotica* leaf meal and Anbarasu et al (2004) observed 29.1 per cent NDF in the leaf meal mixture prepared by mixing *L. leucocephala*, *M. alba* and *T. grandis* in a ratio of 2:1:1. The overall means of ADF content of leaf meal combination prepared from *L. leucocephala, A. catechu* and *A. chinensis* leaves in various ratios was 19.19 per cent. The highest ADF content was in T10 (20.42%) and the lowest ADF content was in T9 (18.66%). Rubanza et al (2007) and Safwat et al (2014) reported 19.7, 9.5 and 25.90 per cent ADF in the leaf meals of *L. leucocephala*, *Acacia nilotica* and *L. leucocephala*, respectively.

The mean NFE content of leaf meal combinations prepared from *L. leucocephala, A. catechu* and *A. chinensis* leaves in various ratios was 50.93 per cent. NFE content among treatments was found highest in T9 (53.23%) and the lowest content was recorded in T10 (47.98%). The findings of Barman and Rai (2003), and Hassan and Abd El-Dayem (2019) reported NFE content between 46.22 to 52.35 per cent in leucaena leaf meal.

Among treatments, the highest total ash content (7.72%) was in T9 and minimum TA content was observed in T10 (6.77%). Anbarasu et al (2004) recorded 11.9 per cent ash content in the leaf meal mixture which was prepared from *Leucaena leucocephala*, *Morus alba* and *Tectona grandis* in 2:1:1 ratio and Acacia leaf meal mixture contained 7.65 per cent ash content as reported by Hassan and Abd El-Dayem (2019). The overall means of AIA content of leaf meal combination prepared from *L. leucocephala, A. catechu* and *A. chinensis* leaves in various ratios was 0.79 per cent. Among treatments, the highest mean acid insoluble ash content (0.86%) was in T8 and minimum AIA content was in T10 (0.72%). The trend of AIA in leaf meal is as T8 > T2 > T5 > T3 ≥ T6 > T1 ≥ T9 > T7 > T4 > T10. Reddy and Elanchezhian (2008) reported that 1.94 per cent AIA was observed in subabul leaf and 0.93 per cent AIA in *Acacia auriculiformis*.

The mean Ca content of leaf meal combinations prepared from *L. leucocephala, A. catechu* and *A. chinensis* leaves in various ratios was 2.19 per cent. The highest value for Ca content was recorded for treatment T9 and lower value for was in T8. The decreasing trend for Ca is as follows T9 > T3 > T7 > T5 > T1 > T10 > T4 > T2 > T6 > T8. Patra et al (2002) reported 1.77 per cent Ca content in leaf meal prepared from the mixture of *L. leucocephala*, *M. alba* and *A. indica* in a 2:1:1 ratio.

Table 2. Nutritive value of different tree leaf meal combinations

Tree leaf meal combination	DM (%)	CP (%)	EE (%)	CF (%)	NDF (%)	ADF (%)	NFE (%)	TA (%)	AIA (%)	Ca (%)	P (%)
T1 (*L. leucocephala: A. catechu: A. chinensis* - 1:1:1)	90.87	16.12^{cdef}	4.14^{abcd}	21.70^{bc}	30.90^{cd}	19.18^{bc}	50.69^{cd}	7.35^{ab}	0.79^{bcd}	2.22^{cd}	0.14^{cde}
T2 (*L. leucocephala: A. catechu: A. chinensis* - 2:1:1)	90.22	17.26^{ab}	4.41^{ab}	19.77^{d}	30.22^{de}	18.92^{bc}	51.03^{cd}	7.53^{a}	0.83^{ab}	1.89^{e}	0.18^{ab}
T3 (*L. leucocephala: A. catechu: A. chinensis* - 1:2:1)	90.42	15.13^{fg}	4.33^{abc}	20.53^{cd}	30.20^{de}	18.78^{c}	52.41^{ab}	7.59^{a}	0.80^{bc}	2.56^{ab}	0.12^{de}
T4 (*L. leucocephala: A. catechu: A. chinensis* - 1:1:2)	90.94	15.78^{ef}	3.89^{bcd}	24.65^{a}	32.55^{ab}	19.70^{ab}	48.69^{ef}	6.99^{bc}	0.74^{de}	2.11^{d}	0.14^{cde}
T5 (*L. leucocephala: A. catechu: A. chinensis* - 2:2:1)	90.54	16.30^{bcde}	4.43^{ab}	19.67^{d}	29.77^{e}	18.71^{c}	51.89^{bc}	7.71^{a}	0.82^{ab}	2.29^{cd}	0.15^{bcd}
T6 (*L. leucocephala: A. catechu: A. chinensis* - 2:1:2)	90.26	16.86^{bcd}	3.78^{cd}	22.17^{b}	31.69^{bc}	19.45^{bc}	49.98^{de}	7.20^{abc}	0.80^{bc}	1.84^{e}	0.17^{abc}
T7 (*L. leucocephala: A. catechu: A. chinensis* - 1:2:2)	90.63	15.16^{fg}	3.99^{abcd}	22.10^{b}	31.56^{bc}	19.35^{bc}	51.53^{bc}	7.22^{abc}	0.76^{cde}	2.42^{bc}	0.12^{de}
T8 (*L. leucocephala: A. catechu: A. chinensis* - 3:1:1)	90.2	18.19^{a}	4.28^{abc}	18.01^{e}	29.90^{de}	18.73^{c}	51.84^{bc}	7.68^{a}	0.86^{a}	1.71^{e}	0.19^{a}
T9 (*L. leucocephala: A. catechu: A. chinensis* - 1:3:1)	90.31	14.48^{g}	4.52^{a}	20.07^{d}	29.72^{e}	18.66^{c}	53.23^{a}	7.72^{a}	0.79^{bcd}	2.74^{a}	0.11^{e}
T10 (*L. leucocephala: A. catechu: A. chinensis* - 1:1:3)	91.07	15.81^{ef}	3.57^{d}	25.87^{a}	33.49^{a}	20.42^{a}	47.98^{f}	6.77^{c}	0.72^{e}	2.12^{d}	0.13^{de}
Mean	90.55	16.11	4.13	21.45	31.00	19.19	50.93	7.38	0.79	2.19	0.15

Means with different superscripts within the column differ significantly ($p<0.05$)
DM (Dry matter), CP (Crude protein), EE (Ether extract), CF (Crude fibre), NDF (Neutral detergent fibre), ADF (Acid detergent fibre), NFE (Nitrogen free extract), TA (Total ash), AIA (Acid insoluble ash), Ca (Calcium) and P (Phosphorus)

Phosphorus plays a crucial role in animal nutrition as it is essential for the development of bones, teeth and nerve cells. The overall means of P content of leaf meal combination prepared from *L. leucocephala, A. catechu* and *A. chinensis* leaves in various ratios was 0.15 per cent. The highest value of P was in T8 (0.19%) and the lowest in T9 (0.11%). Abou-Elezz et al (2011), Brown et al (2016) and Ncube et al (2018) reported 0.24, 0.14 and 0.17 per cent phosphorus content in *L. leucocephala* leaf meal, *Acacia karroo* leaf meal and *Acacia angustissima* leaf meal, respectively.

CONCLUSION

The nutritive value of the tree leaf meal prepared by mixing *L. leucocephala, A. catechu* and *A. chinensis* in the proportion of 3:1:1 was considered as the better tree leaf meal characterized by higher CP and P content with minimum CF, NDF and ADF content. The surplus tree leaves in the monsoon season can be efficiently conserved in the form of tree leaf meal and can be incorporated as a concentrate during the lean period. However, to assess the impact of tree leaf meal on animal health and production, additional animal trials are needed to be carried out.

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