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Utilization of Forage Plants by Livestock of Migrating Gaddi Shepherds in low-altitude scrublands of Hamirpur and Una Districts, Himachal Pradesh

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ABSTRACT: This study investigates the forage species utilised by Gaddi shepherds in the low-altitude scrublands of Hamirpur district, Himachal Pradesh, during their seasonal migrations. The Gaddi community employs traditional knowledge to oversee livestock health and nutrition by utilising a range of plant resources that are well-adapted to the warmer, low-altitude environment. Key forage species identified are Lepidagathiscuspidata, Medicago denticulata, Cynodondactylon, and Grewia optiva, noted for their carbohydrate-rich content and capacity to meet the energy requirements of livestock in these regions. Nutritional analyses reveal significant variability in moisture, ash, protein, fibre, and carbohydrate levels across different species, highlighting the adaptive forage potential of scrubland flora. The results emphasise the sustainable grazing methods employed by Gaddi shepherds, which play a crucial role in preserving biodiversity and maintaining ecological balance in low-altitude scrubland ecosystems. This study deepens the comprehension of forage resources that support pastoral systems and highlights the importance of maintaining traditional knowledge for sustainable livestock management.

KEYWORDS: Gaddi shepherds, forage plants, low-altitude scrublands, sustainable pastoralism, traditional knowledge

I. INTRODUCTION

Transhumant pastoralism represents a traditional way of life in the Himalayan region, intricately woven into the cultural fabric of communities such as the Gaddi shepherds of Himachal Pradesh (Saini, 2020). The Gaddis engage in transhumance, migrating their livestock seasonally between high-altitude summer pastures and low-altitude winter grazing areas. The cyclical movement is essential for sustaining livestock health and productivity, while also contributing to ecological balance via regulated grazing practices (Bhasin, 2011). This practice entails the seasonal movement of livestock, mainly sheep and goats, across varying altitudes to utilise the best grazing resources, a method that corresponds with the climatic and ecological characteristics of the region (Malhotra, 2023; Thakur et al., 2024). This method of regulated foraging enables shepherds to effectively manage rangelands, fostering plant regeneration in grazed regions, minimising soil erosion, and maintaining biodiversity within an integrated land-use framework that combines trees and shrubs with crop and livestock production (Louhaichi et al., 2022). It also supports pastoral practices by improving forage availability and stabilising the ecosystem (Gebeyehu et al., 2021). In the realm of migratory pastoralism, forested and scrubland areas across different altitudes, especially low-altitude scrublands, serve as crucial forage resources for livestock throughout their migration (Dong et al., 2016). The low-altitude scrublands present a varied selection of forage plants that sustain the livestock during the periods when the high-altitude pastures are under snow (Radotra et al., 2015).

The nutritional value of forage plants plays a vital role in maintaining livestock health and enhancing productivity (Geng et al., 2020). For migrating animals, forage that is abundant in proteins, fibres, fats, and minerals is essential for providing sufficient nutrition and energy throughout the demanding migration phases (Khanal et al., 2022). The levels of protein in forage play a vital role in the growth and maintenance of livestock, whereas the fibre content enhances digestive efficiency in ruminants such as sheep and goats (Chand et al., 2022). The values of Neutral Detergent Fibre (NDF) and Acid Detergent Fibre (ADF) are important, as they reflect the digestibility and quality of the forage consumed, which has a direct effect on livestock health during migration (Katoch, 2022).

The knowledge possessed by Gaddi shepherds regarding the selection and nutritional attributes of local flora plays a crucial role in promoting sustainable pastoral practices (Malhotra, 2023). The accumulated wisdom, transmitted across generations, enables shepherds to recognise forage species that fulfil particular dietary requirements and comprehend grazing methods that avert the overexploitation of rangeland resources (Choudhary and Garkoli, 2024). This understanding not only enhances the well-being of their livestock but also plays a vital role in promoting the ecological sustainability of the Himalayan rangelands.

The migratory pastoralism employed by the Gaddi shepherds illustrates a highly adapted approach to managed foraging, leveraging agroforestry resources to ensure the well-being of livestock while safeguarding the ecosystem's integrity (Khanyari et al., 2022). With the growing pressures of climate change and land use, it is essential to comprehend the nutritional quality and ecological significance of forage plants to maintain pastoral systems in the Himalayas.

II. MATERIAL AND METHODS

Study Sites: The study was conducted in the low-altitude scrublands and forested regions of Hamirpur and Una districts, Himachal Pradesh, specifically in the areas of Awahdevi, Tarkwari, Shukkar Khad, Karsai, Barsar and Lathiani forest. These regions serve as significant grazing grounds for the Gaddi shepherds' livestock during their seasonal migration to low altitudes.

Survey, Collection, Identification, and Herbarium Preparation: Field surveys were conducted in these areas, where forage plants commonly used by Gaddi shepherds were identified and collected. Specimens were documented, labelled, and processed for herbarium preparation. The identification of plant species was confirmed through botanical keys and consultations with experts to ensure accuracy.

The Gaddi shepherds' livestock, primarily sheep and goats, were observed browsing various forage plant species. Use Value (UV) was calculated to determine the sustainability of their usage, focusing on the most browsed species. UV was calculated by the following formula $UV = \sum \frac{Ui}{N}$, where Ui denotes the uses cited by each informant for a species, while N represents the total number of informants (Silva et al., 2004).

The ten most commonly used forage plants (Plate 1) were gathered from low-altitude scrublands and assessed for nutritional quality parameters. The plants underwent a series of tests to evaluate moisture, ash, crude protein, crude fat, crude fibre, carbohydrate content, and fibre composition (NDF and ADF) in order to assess their suitability for sustaining the livestock of Gaddi shepherds.

Moisture (%): An empty container was dried at 105°C for 1 hour, chilled in a desiccator, then weighed to estimate moisture content (W1). A leaf sample (W2) weighing 2.000 ± 0.001 g was dried at 105°C until constant weight (W3) was reached, chilled, and reweighed. We estimated moisture (%) by the formula of Unuofin et al. (2017).

$$\text{Moisture } (\%) = \frac{W2 - W3}{W2 - W1} \times 100$$

Ash (%): The ash content was assessed by placing 2 g of a powdered leaf sample into a pre-weighed crucible (W1), followed by combustion at 250°C for 1 hour and subsequently at 550°C for 5 hours in a muffle furnace. Following the cooling process in a desiccator, the crucible underwent reweighing (W3), and the ash content (%) was determined using the following calculation of Unuofin et al. (2017).

$$\text{Ash } (\%) = \frac{W2 - W3}{W2 - W1} \times 100$$

Crude Fat (%): Crude fat was extracted from a 5 g leaf powder sample utilising 100 mL of diethyl ether, agitated for a duration of 24 hours, and subsequently filtered. The extract underwent evaporation, followed by the drying and reweighing of the beaker (W2). The calculation for crude fat content (%) was performed as given by Unuofin et al. (2017).

$$\text{Crude Fat } (\%) = \frac{\text{Weight of Flask with Fat} - \text{Weight of Empty Flask}}{\text{Weight of Original Sample}} \times 100$$

Crude Fiber(%): The determination of crude fiber involved digesting a 2 g dried leaf sample in 100 mL of 1.25% sulphuric acid for a duration of 30 minutes, after which filtration and rinsing were performed. The procedure was conducted again using 1.25% sodium hydroxide (NaOH). The residue underwent drying, followed by weighing (C1), combustion, and subsequent reweighing (C2). The calculation for crude fibre (%) was performed by the formula of Unuofin et al. (2017).

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$$\text{Crude Fiber (\%)} = \frac{C2 - C1}{\text{Weight of Original Sample}} \times 100$$

Crude Protein: The determination of protein content was conducted utilising the Kjeldahl method. A 2 g leaf sample underwent digestion, distillation, and titration to quantify nitrogen, subsequently converting this measurement to protein using a factor of 6.25 (Unuofin et al., 2017).

$$([(\text{ml Standard Acid} \times \text{N of Acid}) - (\text{ml Blank} \times \text{N of Base})] - (\text{ml Standard Base} \times \text{N of Base}) \times 1.4007) / (\text{Weight of Sample in Grams})$$

Carbohydrate: The carbohydrate content was calculated by deducting the total values of moisture, ash, crude fat, crude fibre, and crude protein from 100 (Unuofin et al., 2017).

$$\text{\% Total Carbohydrate} = 100 - (\text{\%Moisture Content} + \text{\%Ash Content} + \text{\%Crude Fat} + \text{\%Crude Fiber} + \text{\%Crude Protein})$$

Neutral Detergent Fibre: The determination of NDF was conducted following the method established by Soest and Wine (1967). A 500 mg dried leaf sample underwent reflux in 100 mL of a neutral detergent solution, which included 2 mL of decahydronaphthalene and 0.5 g of sodium sulphate, for a duration of 60 minutes. The residue underwent filtration, followed by washing with hot distilled water and acetone. It was then dried at 100°C for a duration of 8 hours, allowed to cool, and subsequently weighed. NDF percentage was determined using the following formula:

$$\text{NDF (\%)} = ((\text{Weight of Crucible} + \text{Fiber Content}) - \text{Weight of Empty Crucible}) / (\text{Weight ofSample}) \times 100$$

Acid Detergent Fibre: The determination of ADF was conducted following the method established by Soest and Wine (1967). A 500 mg sample of dried leaf was subjected to reflux in 100 mL of acid detergent solution, incorporating 2 mL of decahydronaphthalene, for a duration of 1 hour. Following this, the mixture was filtered, washed with hot water (90-100°C) and acetone, and subsequently dried at 100°C for 8 hours. The residue was subsequently weighed.

$$\text{ADF (\%)} = ((\text{Weight of Crucible} + \text{Fiber Content}) - \text{Weight of Empty Crucible}) / (\text{Weight ofSample}) \times 100$$

III. RESULTS

The migratory Gaddi shepherds' sheep and goats foraged on 54 different plant species in the low-altitude scrublands of Hamirpur and Una districts (Table 1). This diverse diet included 22 herbs, 13 shrubs, 10 trees, 6 grasses, 2 climbers, and 1 fern. The species that were commonly utilised included Rubus ellipticus, Ziziphus mauritiana, Jasminum laurifolium, Medicago denticulata, Mallotusphilippensis, Berberis asiatica, Cynodondactylon, Carissa spinarum, Lepidagathiscuspidata, and Grewia optiva. Additional species of preference, ranked by usage, comprised Pyrus pashia, Indigofera heterantha, Bidens pilosa, Cissampelos pareira, among others. The forage plants were classified into 30 families, with the highest representation from Fabaceae, comprising 7 species, and Poaceae, which included 6 species (Fig. 1). The parts utilised for foraging included herbs (41%), shrubs (24%), trees (18%), grasses (11%), climbers (4%), and ferns (2%), highlighting the plant diversity present in the low altitude scrubs and the particular foraging preferences of the shepherds (Fig. 2).

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Fig. 1. Forage Plants from Low Altitude Scrublands

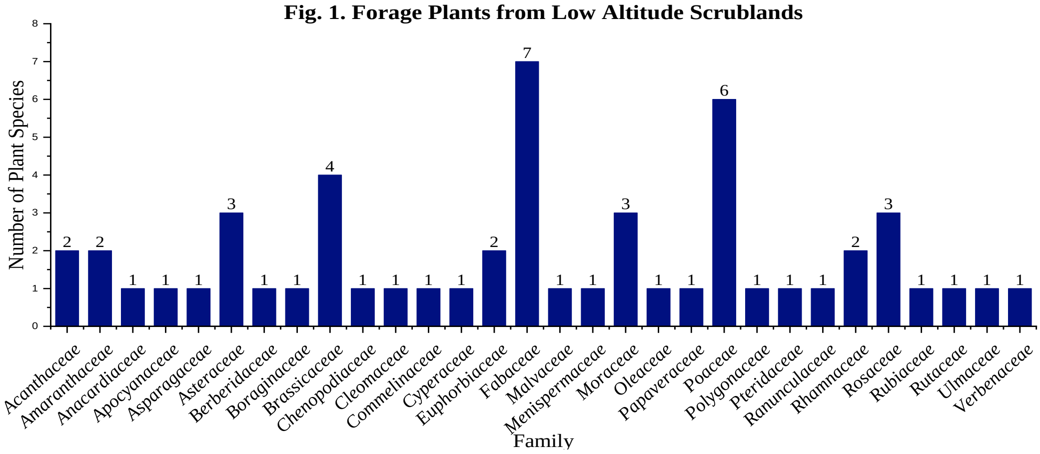


Fig. 2. Utilization pattern of fodder plants in Low-Altitude Scrubs

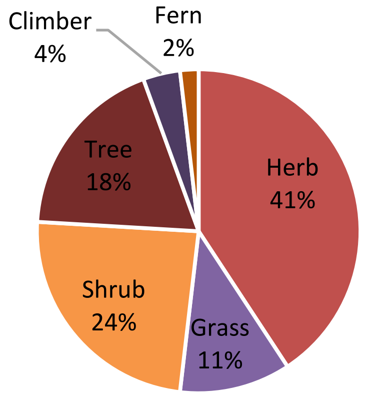
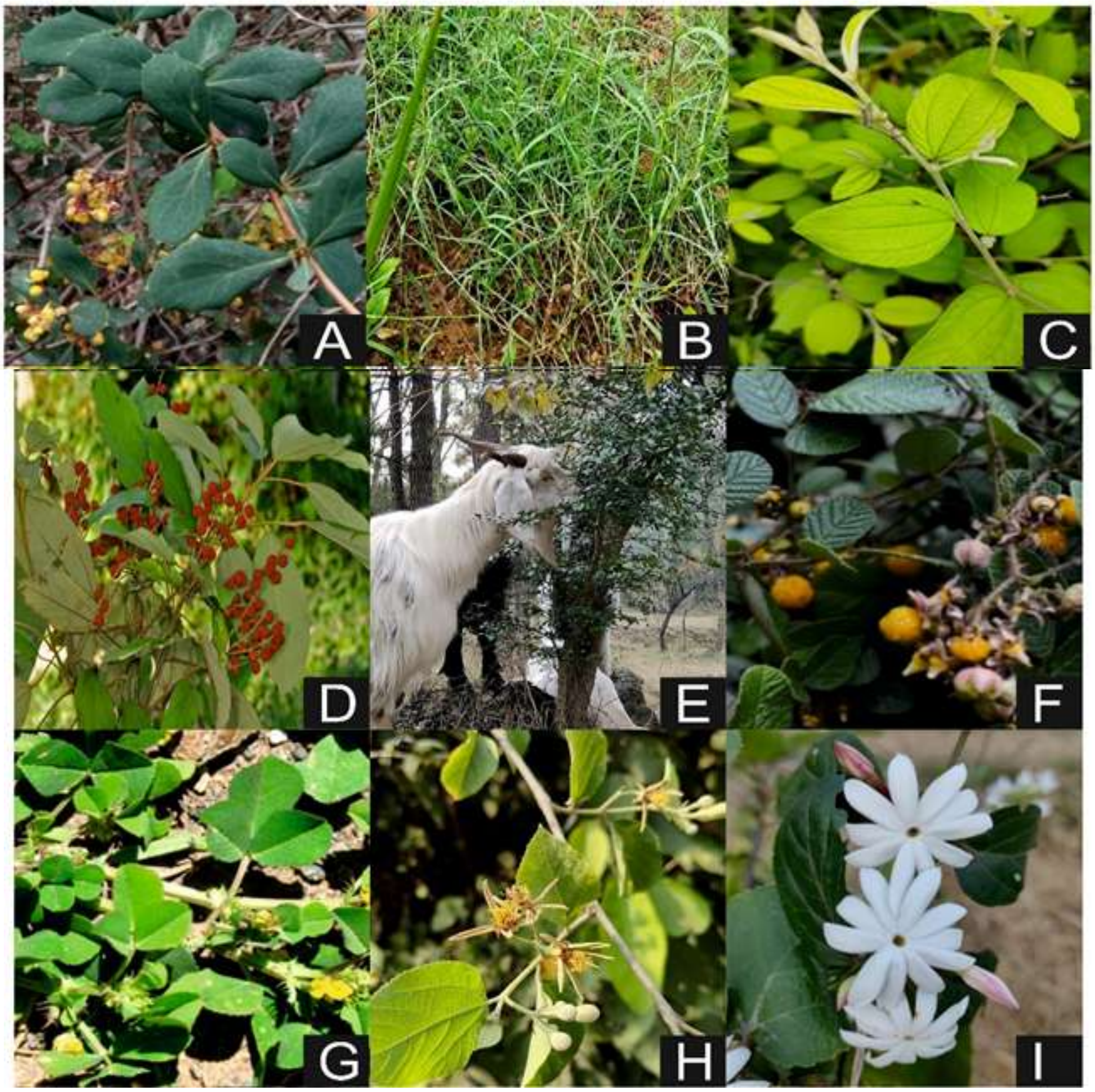


Table 1: Forage plants of Low-Altitude Scrubs which are preferably browsed by sheep and goats.

Sr. No.	Botanical name	Family	Common Name	Habit	Use Value
1	Rubus ellipticusSm.	Rosaceae	Aakhe	Shrub	1.00
2	Ziziphus mauritianaAdans	Rhamnaceae	Malhi	Shrub	1.00
3	Jasminum laurifoliumRoxb. ex Hornem.	Oleaceae	Malti	Shrub	1.00
4	Medicago denticulata Willd.	Fabaceae	Droda	Herb	1.00
5	MallotusphilippensisMuell.-Arg.	Euphorbiaceae	Kamal	Shrub	1.00
6	Berberis asiatica Royle Ex DC.	Berberidaceae	Kasmal	Shrub	0.98
7	Cynodondactylon(L.) Pers.	Poaceae	Drub	Grass	0.98
8	Carissa spinarumL.	Apocyanaceae	Garna	Shrub	0.98
9	LepidagathiscuspidataNees	Acanthaceae	Braalu	Herb	0.98
10	Grewia optivaJ.R.Drumm. ex Burret	Malvaceae	Bihyul	Tree	0.97

11	Pyrus pashiaL.	Rosaceae	Kainth	Tree	0.95
12	Indigofera heteranthaWall. ex Brandis.	Fabaceae	Kathu	Shrub	0.95
13	Bidens Pilosa L.	Asteraceae	Gumbar	Herb	0.94
14	Cissampelos pareira L.	Menispermaceae	Patindu	Herb	0.94
15	Cassia fistula L.	Fabaceae	Braalu	Tree	0.94
16	Mimosa rubicaulisLam.	Fabaceae	Bargneya	Shrub	0.94
17	Arundinaria falcata Nees	Poaceae	Bainjhi	Grass	0.92
18	Bauhinia vahliiL.	Fabaceae	Taureya	Climber	0.92
19	Chenopodium album L	Chenopodiaceae	Bathua	Herb	0.92
20	Randia dumetorum(Retz.) Lam.	Rubiaceae	Rada	Shrub	0.92
21	Acacia catechu Brandis	Fabaceae	Khair	Tree	0.91
22	BrasssicacompestrisL.	Brassicaceae	Sarhon	Herb	0.91
23	Brassica napus L.	Brassicaceae	Sarhon	Herb	0.91
24	Brassica nigra (L.) Andrz.	Brassicaceae	Kali Sarhon	Herb	0.91
25	CommelinabenghalensisL.	Commelinaceae	Sanspayi	Herb	0.91
26	Xanthium strumariumL.	Asteraceae	Jhinjhre	Herb	0.91
27	EcliptaprostrataL.	Asteraceae	Bhringraj	Herb	0.90
28	Morus alba L.	Moraceae	Toot	Tree	0.90
29	Clematis grata Wall.	Ranunculaceae	Santai	Climber	0.89
30	Fumaria parviflora Lam.	Papaveraceae	Pitpapda	Herb	0.89
31	Albizia lebbeck(L.) Benth.	Fabaceae	Sarinh	Tree	0.88
32	Ficus palmata Forssk.	Moraceae	Faguda	Tree	0.87
33	DiclipterabupleuroidesNees	Acanthaceae	Kali basuti	Herb	0.87
34	Rosa moschata Herrm.	Rosaceae	Kujeya	Shrub	0.86
35	Ziziphus oenopolia(L.) Mill.	Rhamnaceae	Kangu	Shrub	0.86
36	Alkanna tinctoria Tausch	Boraginaceae	Neeli	Herb	0.86
37	Asparagus filicinusBuch.-Ham. ex D.Don	Asparagaceae	Sanspai	Herb	0.85
38	Rumex hastatusD. Don	Polygonaceae	Khatti mithi	Herb	0.85
39	Lepidium verginicumL.	Brassicaceae	Alon	Herb	0.84
40	Amaranthus viridisL.	Amaranthaceae	Chulai	Herb	0.84
41	Cyperus rotundusHook. F.	Cyperaceae	Motha	Herb	0.84
42	Cymbopogon martini (Roxb.) Wats.	Poaceae	Makoda	Grass	0.83
43	Bambusa arundinaceaBonpl.	Poaceae	Bainj	Grass	0.83
44	Celtis australis L	Ulmaceae	Khidak	Tree	0.82
45	Pistacia chinensis Bunge	Anacardiaceae	Kkakadsingi	Tree	0.81

46	Achyranthes aspera L.	Amaranthaceae	Puthkanda	Herb	0.81
47	Cleome viscosaL.	Cleomaceae	Jangalisarhon	Herb	0.80
48	Brachiariaramosa(L.) Stapf	Poaceae	Butrri	Grass	0.79
49	Adiantum venustumD.Don	Pteridaceae	Morshikha	Fern	0.76
50	Euphorbia helioscopia L.	Euphorbiaceae	Dudhla	Herb	0.69
51	Sorghum helepence(L.) Pers.	Poaceae	Baru	Grass	0.69
52	MurrayakoenigiiL.	Rutaceae	Kandhela	Shrub	0.47
53	Broussonetia papyriferaL.	Moraceae	Bantoot	Tree	0.47
54	Lantana camara L.	Verbenaceae	Fulbari	Shrub	0.40



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A. *Berberis asiatica* Roxb. ex DC.
B. *Cynodon dactylon* (L.) Pers.
C. *Ziziphus mauritiana* Lam.
D. *Mallotus philippensis* (Lam.) Müll.Arg.
E. *Carissa spinarum* L.
F. *Rubus ellipticus* Sm.
G. *Medicago denticulata* Willd.
H. *Grewia optiva* J.R.Drumm. ex Burret
I. *Jasminum laurifolium* Roxb. ex Hornem.
J. *Lepidagathis cuspidata* Nees

Plate: 1. 10 most forage plants by Gaddi shepherds' livestock in low-altitude scrublands

Physicochemical Analysis:

The Table No. 2 shows the results of forage nutrition quality analysis in 10 most used forage plants. The moisture content analysis revealed that Lepidagathiscuspidata had the highest moisture content at 44.27%, whereas Cynodondactylon recorded the lowest at 33.73%. The highest ash contents were recorded for Ziziphus mauritianaat 5.97% and Berberis asiatica at 5.50%, while Medicago denticulata exhibited the lowest at 1.87%. The crude fat content analysis revealed that Grewia optiva exhibited the highest level at 1.59%, with Lepidagathiscuspidata following closely at 1.44%. In contrast, Carissa spinarum recorded the lowest content at 1.00%. ANOVA revealed notable differences ($F = 4.744$, $p = 0.002$). The highest crude fibre contents were observed in Mallotusphilippensis and Jasminum laurifolium, both at approximately 29.4%, whereas Lepidagathiscuspidata exhibited the lowest at 18.74%. Jasminum laurifolium and Grewia optivashowed the highest crude protein contents at 5.27% and 5.22%, respectively, while Berberis asiatica and Ziziphus mauritianarecorded the lowest at around 4.15%. The carbohydrate content varied among the species, with Medicago denticulata exhibiting the highest level at 36.77%, whereas Jasminum laurifolium displayed the lowest at 23.98%. Ziziphus mauritiana and Berberis asiatica demonstrated the highest NDF levels at around 59%, suggesting an increased presence of cell wall components that may impair digestibility. Rubus ellipticus exhibited the lowest NDF, recorded at 50.14%. The highest ADF content was observed in Mallotusphilippensis at 52.23%, whereas Rubus ellipticus exhibited the lowest content at 41.42%.

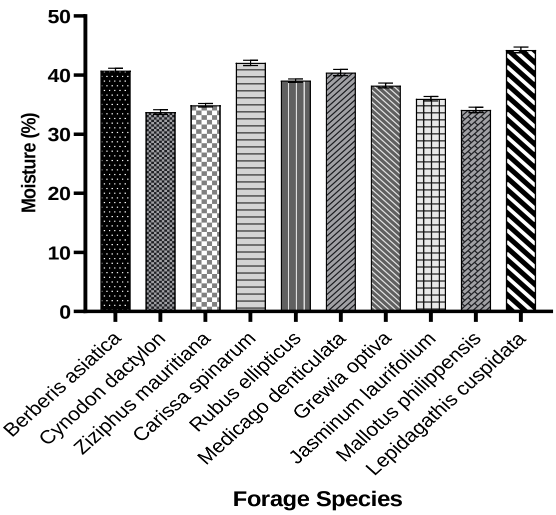

Fig. 3: Moisture content in leaves of fodder species in low-altitude scrublands (n=3, mean ± SE).

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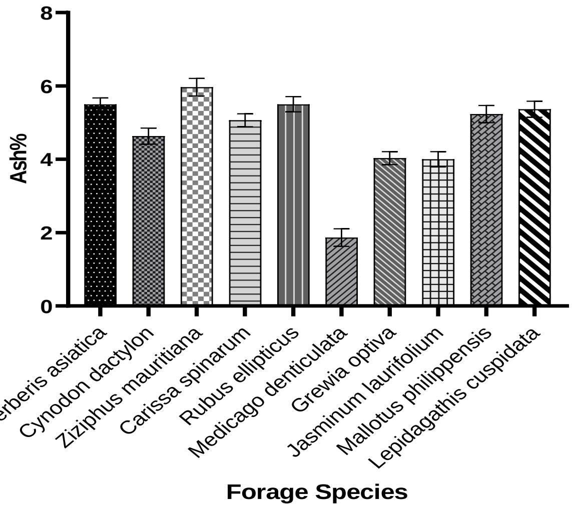

Fig. 4: Ash content in leaves of fodder species in low-altitude scrublands (n=3, mean ± SE).

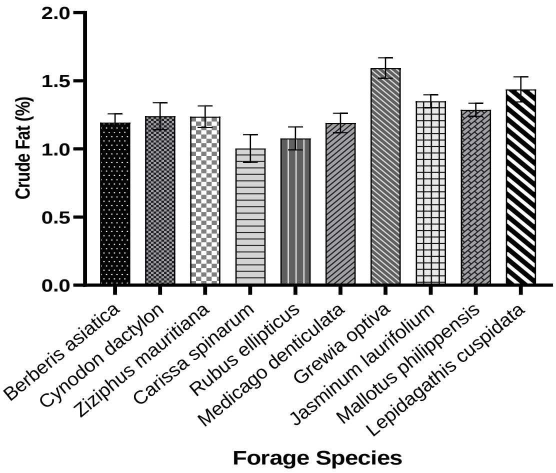

Fig. 5: Crude Fat content in leaves of fodder species in low-altitude scrublands (n=3, mean ± SE).

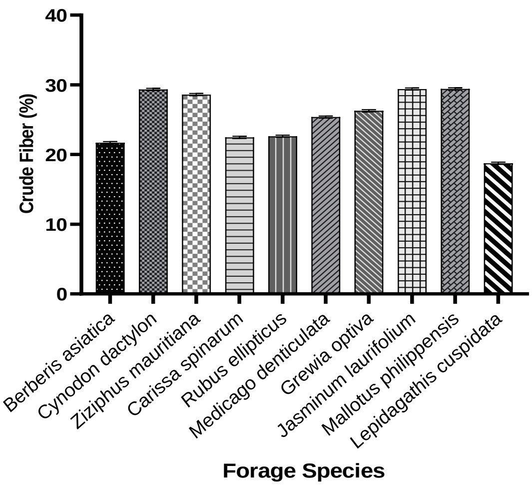

Fig. 6: Crude Fiber content in leaves of fodder species in low-altitude scrublands (n=3, mean ± SE).

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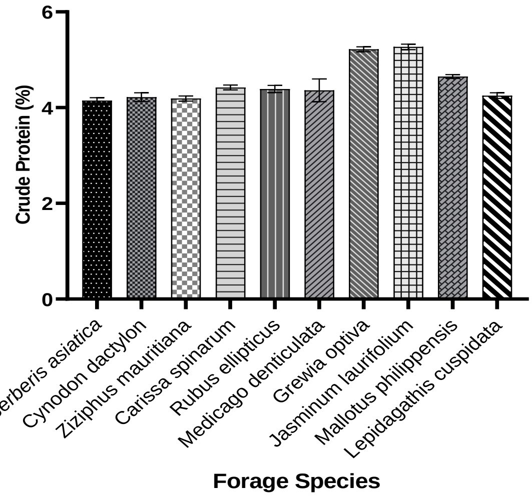

Fig. 7: Crude protein content in leaves of fodder species in low-altitude scrublands (n=3, mean ± SE).

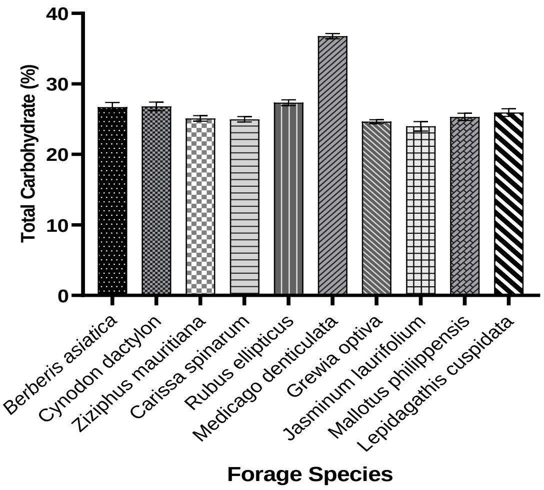

Fig. 8: Carbohydrate content in leaves of fodder species in low-altitude scrublands (n=3, mean ± SE).

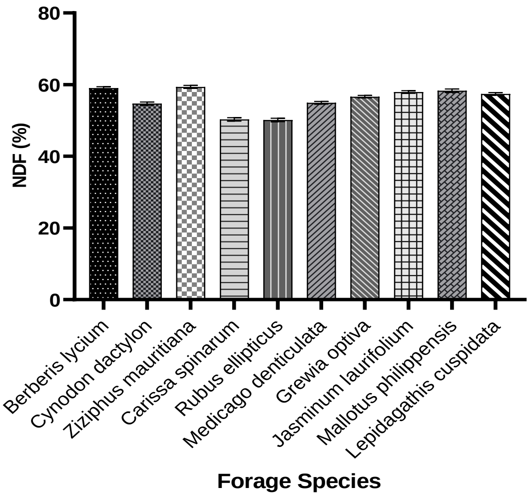

Fig. 9: NDF content in leaves of fodder species in low-altitude scrublands (n=3, mean ± SE).

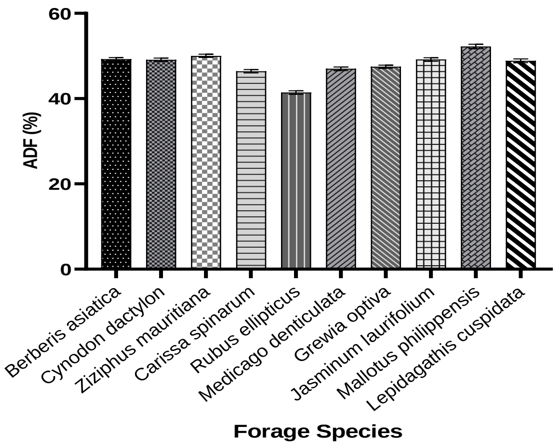

Fig. 10: ADF content in leaves of fodder species in low-altitude scrublands (n=3, mean ± SE).

Table: 2. Forage nutrition quality analysis in most used forage plants of Low Altitude Scrublands									
Sr. No.	**Name of Plant**	**Moisture**	**Ash**	**Crude Fat**	**Crude Fiber**	**Crude Protein**	**Total Carbohydrate**	**NDF**	**ADF**
1.	Berberis asiatica	40.76 ±0.406	5.50 ±0.173	1.19 ±0.064	31.03 ±0.817	4.15 ±0.058	17.37 ±1.294	59.05 ±0.397	49.26 ±0.361
2.	Cynodondactylon	33.73 ±0.393	4.63 ±0.219	1.24 ±0.099	29.35 ±0.161	4.22 ±0.091	26.82 ±0.602	54.71 ±0.463	49.12 ±0.385
3.	Ziziphus mauritiana	34.90 ±0.300	5.97 ±0.240	1.24 ±0.079	28.93 ±0.345	4.19 ±0.055	24.77 ±0.320	59.37 ±0.401	50.04 ±0.365
4.	Carissa spinarum	42.07 ±0.433	5.07 ±0.176	1.00 ±0.101	22.46 ±0.159	4.42 ±0.052	24.98 ±0.391	50.31 ±0.458	46.42 ±0.408
5.	Rubus ellipticus	39.07 ±0.285	5.50 ±0.208	1.08 ±0.084	31.30 ±0.944	4.39 ±0.076	18.67 ±0.791	50.14 ±0.459	41.42 ±0.408
6.	Medicago denticulata	40.43 ±0.524	1.87 ±0.240	1.19 ±0.071	25.38 ±0.148	4.36 ±0.237	36.77 ±0.369	54.94 ±0.348	47.00 ±0.426
7.	Grewia optiva	38.23 ±0.418	4.03 ±0.176	1.59 ±0.075	33.61 ±0.721	5.22 ±0.052	17.31 ±0.444	56.65 ±0.335	47.49 ±0.352
8.	Jasminum laurifolium	36.00 ±0.379	4.00 ±0.208	1.35 ±0.047	29.40 ±0.144	5.27 ±0.057	23.98 ±0.671	57.96 ±0.375	49.17 ±0.398
9.	Mallotusphilippensis	34.10 ±0.462	5.23 ±0.233	1.29 ±0.048	32.42 ±0.665	4.65 ±0.041	22.32 ±1.053	58.33 ±0.461	52.23 ±0.3517
10.	Lepidagathiscuspidata	44.27 ±0.491	5.37 ±0.219	1.44 ±0.092	28.34 ±0.283	4.25 ±0.060	16.33 ±0.905	57.41 ±0.374	48.88 ±0.420

IV. DISCUSSION

The low-altitude scrublands of Himachal Pradesh, specifically in Hamirpur and Una districts, provide a diverse array of forage plants that are vital for the sustenance of Gaddi livestock during the winter months. These areas offer various native grasses and legumes that, although less nutrient-dense than the high-altitude alpine pastures, play an essential role in sustaining migrating livestock for 3-4 months when the high-altitude regions are covered in snow (Nehria and Ghosh, 2024). This diversity supports Gaddi pastoralists' transhumant practices, allowing them to rely on locally available forage to maintain their herds through the winter season (Mishra et al., 2023; Choudhary and Garkoli, 2024).

However, the forage in these low-altitude areas generally has a lower nutritional profile, as indicated by physicochemical analyses of key parameters such as moisture, ash, crude fat, crude fiber, crude protein, carbohydrates, Neutral Detergent Fiber (NDF), and Acid Detergent Fiber (ADF). This is in agreement with earlier such study of Katoch and Tripathi (2020) which revealed that white clover (Trifolium repens L.) from higher altitudes exhibits greater nutritional superiority when compared to that from lower altitudes. The results are consistent with earlier research showing that the moisture content in forage plants can fluctuate significantly, affecting both palatability and consumption by livestock (Cain et al., 2017). Similar variations in ash content among forage species have been observed in other regions (Katoch, 2022). The forage plants of low-altitude scrublands have been found to have lesser crude fat content. These findings are in agreement with study of Rochana et al. (2016). The higher levels of NDF and ADF observed in these forage plants, typical of low-altitude scrublands, signify a greater proportion of indigestible components (Karabulut and Çomakli, 2023). High NDF values impede the digestion process and, as a result, lead to a physical sensation of fullness in the animal, thereby reducing intake (Harper and McNeill, 2015).

In terms of protein content, these low-altitude forages provide sufficient crude protein to meet basic maintenance needs but are less nutritive than the high-altitude forages rich in protein and digestible carbohydrates (Katoch, 2022). Previous research has documented that high-protein forages, especially legumes, significantly enhance livestock productivity by meeting the elevated nutritional requirements during demanding periods like lactation and growth (Lemus, 2020; Solomon, 2022). Yet, despite the relatively lower nutritive value of low-altitude scrubland forages, their abundance and accessibility make them indispensable during winter months, ensuring that livestock maintain baseline health and energy levels without requiring supplemental feeding.

Overall, the findings underscore the ecological importance and economic value of low-altitude scrublands in supporting Gaddi pastoralism. These forages, while less nutrient-dense, align with other studies in similar ecological zones, confirming consistent physicochemical profiles that help livestock meet essential dietary needs through challenging winter months (Kumar et al., 2022). Further research into forage improvement and supplementation strategies could enhance the productivity of livestock relying on these low-altitude resources.

V. CONCLUSION

This investigation highlights the critical role of low-altitude scrublands in the Hamirpur and Una districts for the sustenance of Gaddi livestock throughout the winter season. Although these forages may not be as nutrient-rich as those found in high-altitude pastures, their variety and accessibility offer crucial nourishment during periods when alpine regions are blanketed in snow. The examination of physicochemical parameters, including NDF and ADF, verifies a significant fibre content that restricts digestibility while providing sufficient bulk to satisfy livestock requirements. The results highlight the importance of implementing effective management and possible supplementation strategies to improve livestock health and productivity, thereby supporting the practices and livelihoods of Gaddi pastoralists in the area.

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