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CHEMICAL COMPOSITION AND GRAZING PREFERENCE OF RANGELANDS PLANTS BY SMALL RUMINANTS OF SURAB DISTRICT BALOCHISTAN, PAKISTAN

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Abstract
Small ruminants, such as sheep and goats, primarily obtain their feed from rangelands. Therefore, understanding the chemical composition of rangeland forages and the grazing preferences of these animals is essential for effective livestock production. This study aimed to determine the chemical composition and grazing preferences of rangeland plant species by small ruminants in three areas (Giddar, Marap, and Dasht) of the Surab region, Balochistan. A baseline survey was conducted, and forage samples (n = 15) were collected for chemical analysis of dry matter (DM), crude protein (CP), ether extract (EE), crude fiber (CF), neutral detergent fiber (NDF), acid detergent fiber (ADF), starch, and ash. The most preferred plant species were Peganum harmala, Gallaniam afghanica, Gentiana kurro, Nepeta juncea, Artemisia scoparia, and Cousinia stcoksi. Among the 15 species identified, approximately 40% and 47% were rated as highly and moderately palatable, respectively. Significant differences (P < 0.05) in nutrient content were observed among the rangeland plants. Crude protein content ranged from 5.27% to 12.6%. The Surab region contains highly preferred forage species that can supply essential nutrients including crude protein and crude fiber to grazing sheep and goats in the area.
Keywords: *Chemical composition, Palatability, Rangeland plants, Small ruminant, Utilization*

INTRODUCTION

Small ruminants such as sheep and goats are important livestock species and play a vital role in desert climates. Due to their distinct grazing habits and physiological adaptations, they are able to browse on plants that other animals typically avoid. Pakistan's estimated sheep and goat populations are around 32.7 and 87.0 million, respectively (1). The livestock sector has become Pakistan's largest agricultural contributor, accounting for approximately 60.8% of agricultural value and 14.6% of the national GDP (1). In Balochistan, livestock rearing is the primary economic activity, with sheep and goats being the dominant species. Approximately 87% of Balochistan's population depends directly or indirectly on livestock farming for their livelihood (2).

Balochistan's rangelands contain a diverse array of trees, herbs, shrubs, and grasses that play a vital role in providing feed for domestic livestock. These rangelands satisfy about 90% of livestock feeding needs in the region (3). They primarily sustain small ruminants, particularly in nomadic and transhumant production systems. Despite their ecological and economic importance, these rangelands face degradation from grazing pressure, population growth, vegetation changes, and tribal conflicts, which threatens their sustainability (4). Prolonged drought, soil erosion, and human activities were identified as primary factors contributing to rangeland deterioration in the region (5). Pastoralists face numerous challenges, with winter feed shortages being particularly severe (6, 7). Key rangeland management challenges in Balochistan include open range systems with undefined land ownership, limited community participation, frequent droughts, insufficient knowledge about forage species productivity, and a lack of integrated management approaches.

Factors such as phenological stage, plant part, location, environmental conditions, and species or cultivar differences influence the nutritive value of rangeland forages (8).

Livestock productivity in Balochistan's rangelands depends on both forage quantity and nutritional value. Therefore, a clear understanding of forage chemical composition is essential for livestock producers to assess nutritional value and address potential deficiencies through supplementation. The nutritive value of rangeland forage plants varies due to climatic and topographical differences. For example, higher levels of hemicellulose, dry matter (DM), crude fiber (CF), nitrogen-free extract (NFE), neutral detergent fiber (NDF), and acid detergent fiber (ADF) were reported in grass species compared to shrubs from Harboi, Kalat (9).

Very little is known about the nutritive value, palatability, and preferences of livestock in the Surab region of Balochistan. We hypothesized that small ruminants in the Surab region have varying preferences for different types of rangeland plants for grazing and browsing to obtain nutrients. Therefore, this study aimed to identify the preferred rangeland species in the Surab region and determine their nutritional profiles. This is critical to fill the gap by providing a comprehensive assessment of both the nutritional composition and the palatability preferences of small ruminants for local rangeland plant species in the Surab district of Balochistan. The findings will inform feeding strategies to enhance livestock health, productivity, and economic returns.

METHODOLOGY

DESCRIPTION OF STUDY AREA

The study area is located in western Balochistan's Kalat Division at an elevation of 1,762.26 m above sea level (66°15'35"E longitude, 28°29'33"N latitude), covering 762 km². The Surab region has a subtropical desert climate characterized by hot summers (May to August) and cold winters (November to February) with low humidity. The average annual high temperatures are 42.92°C (July) and 17.22°C (January), with 23.6% relative humidity and 13.67 mm annual precipitation. Despite low moisture conditions, the area supports rich flora and fauna at moderate temperatures. The Surab region's topography is characterized by steep, rough terrain, which is essentially a vast, rocky plateau. Mountain ranges split the plateau into different basins. The botanical distribution includes important hemi-cryptophytes (perennial plants) and micro-phenrophytes (small shrubs), nanophylls, microphylls and mesophylls. The local flora faces threats from factors like deforestation, over-exploitation, and soil erosion.

SURVEY AND DATA COLLECTION

Basic information on farmer education levels, animal populations, and feeding practices in Giddar, Marap, and Dasht was collected through questionnaires administered to local shepherds/farmers. The research area was selected based on rich forage plants habitant occupied by livestock farmer community with sound communication road facility and cell phone facility. The respondents were selected voluntarily with minimum 150 animals (sheep and goat) and 5-6 years livestock rearing experiences with primary education were selected. A total of 45 livestock farmers (15 per site) were interviewed about grazing/browsing preferences and most utilized plants by ruminants. Field visits were conducted frequently twice a week two consecutive months to gather information through informal interviews with residents and livestock farmers. Grazing status was determined by directly observing each stand and classified as overgrazed, moderately grazed, minimally grazed, and no grazing (10). The palatability was determined by observation of the grazing livestock (cattle, sheep, goats, and camels) in the field for two consecutive months according to forage plant browsed and animal preferences. These field observations were further supported by information obtained from nomadic and livestock keeping populations in various Surab region range cities. Plants were categorized using (9) classification, including highly palatable (HP): predominantly favored by grazing animals, moderately palatable (MP): Moderately consumed, rarely palatable (RP): Consumed only when alternatives are unavailable. The information gathered was verified by consulting relevant published literature (9-14).

FORAGE SAMPLING AND IDENTIFICATION

Sampling was done at the time of grazing. Forage samples (grasses, herbs, shrubs; ~2-3 kg) were collected in triplicate (n=3) from each grazing site/browsing (Giddar, Marap, Dasht) during March-May 2024. The forages were sampled with clean scissors or shears and then to cut 3-4 sub samples from the top 5-6 inches of plant in random location across the field to create representative composite sample for analysis. The samples of same species obtained from different location were mix thoroughly for further analysis.

Samples consisted primarily of edible parts (leaves, twigs, inflorescences), labeled with local names, and transported the same day to Lasbela University of Agriculture, Water and Marine Sciences (LUAWMS), Uthal. Local names were verified by shepherds/farmers, with taxonomic identification confirmed by botanical experts from LUAWMS's Faculty of Crop Sciences (Table II).

ANALYSIS OF CHEMICAL COMPOSITION

Samples were shade-dried, then oven-dried at 65°C for 48 hours. Dried material was ground (1 mm sieve, Wiley Mill) and stored in plastic zipper bags for analysis. Chemical analyses included dry matter (DM), ash, crude protein (CP), ether extract (EE), and crude fibre (CF) was evaluated according to established method (15). DM was determined by placing samples in oven at 105 ^{0}C overnight. CP contents were determined using Kjeldhal apparatus. The three major steps were involved in this technique i.e., digestion, distillation and titration. The distilled sample was titrated against N/10 H_2SO_4 to calculate % of nitrogen. The percent nitrogen obtained as a result of this procedure was multiplied by 6.25 factors to get the value of crude protein in the sample. The crude fat contents (EE) in samples were determined by using soxhlet extraction unit. The samples placed in the extraction unit were extracted repeatedly with petroleum ether that dissolved fat from the sample. The collected EE in extraction tubes were dried oven at 60 ^{0}C for overnight and calculated for fat %. Ash was determined by igniting the sample at 600 ^{0}C in muffle furnace and calculated for total ash. Carbohydrate fractions including ADF, NDF, and starch were evaluated according to the methods described by (16). All variables are determined at Total Nutrition Feed Insight Lab Service, Lahore (ADF/NDF/starch) and Animal Nutrition Laboratory, LUAWMS (proximate analysis).

STATISTICAL ANALYSIS

Nutrient data (DM, CP, EE, CF, starch, NDF, ADF, ash) were analyzed using ANOVA (17) . Mean differences were tested with LSD ((18) and Duncan's multiple range test (19) . The alpha level 0.05 was used to declare significance.

RESULTS

FARMER DEMOGRAPHY AND GRAZING PREFERENCE

The basic data of the region (Giddar, Marap and Dasht) presented in Table I provides information on livestock farmers' education level, flock/herd composition, feeding habits, and grazing time. Among the livestock farmer community 40 % had no formal education, 20 % had middle-level education, and the remaining 40 % had primary education. The area total flock/herd size is 7301.0 numbers which comprised of goats (3387.0) and sheep (3914.0), with sheep being more numerous (53.6 %) than goats (46.4 %) in Surab district (Table I). The most common feeding practice was grazing only (44.4 %), followed by grazing + fodder + crop residues practiced by 22.2 % (Table I). Other feeding practices included grazing + crop residues (17.8 %), grazing + fodder (6.7 %), and grazing + fodder + concentrate (8.9 %). Regarding grazing time, farmers most frequently grazed livestock from morning to evening (40 %), followed by morning only (30 %), with noon to evening being the least preferred time (20 %).

IDENTIFICATION AND ANIMAL PREFERENCE OF RANGELAND SPECIES

Livestock farmers identified and named fifteen rangeland species based on animal preferences using local names, while botanical identification was conducted by experts from the Faculty of Agricultural Sciences at LUAWMS Uthal, Balochistan. Based on growth habit and botanical properties, the rangeland

plants were categorized as shrubs (7), herbs (5), and grasses (3). Based on animal grazing preferences, the species *Peganum harmala, Gallaniam afghanica, Gentiana kurro, Nepeta juncea, Artemisia scoparia*, and *Cousinia stcoksi* were determined to be highly palatable, while, *Sophora mollis, Astragalus hyrcanus, Paspalum vaginatum, Cylindropuntia ramosissuma, Haloxylon griffithii, Launaea arborescens* and *Cyclolepis genistoides* were moderately palatable (Table II). *Rhanterium epapposum, and Lycium edgewarthii* were rarely palatable (consumed only when alternatives are unavailable).

Table I. Farmer's education level, flock composition and feeding practice of livestock

Category	Variables	Percent share
Education level	Primary	40.00
	Middle	20.00
	Not educated	40.00
	Total	100.0
Flock compositions	Goat	46.40
	Sheep	53.60
	Total	100.0
Feeding practice	Grazing	44.44
	Grazing + Crop residue	17.78
	Grazing + Fodder	6.67
	Grazing + Fodder + Crop residue	22.22
	Grazing + Fodder + Concentrate	8.89
	Total	100.0

Table II. Identification of rangeland species preferred by livestock in Surab region Giddar, Marap and Dasht

S. No	Local Name	Botanical Name	Family	Palatability
1	Shalwarjirr	*Lycium edgewarthii*	Sub-shrub	RP
2	Borako	*Rhanterium epapposum*	Shrub bushy	RP
3	Rang	*Astragalus Hyrcanus*	Herb	MP
4	Simsok	*Nepeta juncea*	Grass	HP
5	Shampashteer	*Sophora mollis*	Shrub	MP
6	Guather	*Paspalum vaginatum*	Perennial grass	MP
7	Chughi	*Cylindropuntia ramosissuma*	Tree like shrub	MP
8	Bundi	*Haloxylon griffithii*	Shrub	MP
9	Jirr	*Artemisia scoparia*	Herb	HP
10	Tosso	*Gallanium afghanica*	Shrub	HP
11	Kurro	*Gentiana kurro*	Herb	HP
12	Kisankoor	*Peganum harmala*	Herb	HP
13	Naryanband	*Cousinia stcoksi*	Grass	HP
14	Delakoon	*Launaea arborescens*	Shrub	MP
15	Giddri	*Cyclolepis genistoides*	Herb	MP

*HP= highly palatable, MP= moderately palatable, RP=rarely palatable

CHEMICAL COMPOSITION OF RANGELAND PLANTS

Chemical composition (DM, CP, EE and Ash) of the rangeland plants are described in Table III. The DM contents ranged from 93.11 % to 95.24%. *Peganum harmala* (12.6 ± 0.4 %) and *Sophora mollis* (12.56 ± 0.4 %) had the highest crude protein (CP) concentrations. The lowest CP content was observed in *Gallaniam afghanica* (5.27 ± 0.27 %). *Cylindropuntia ramosissuma* had the lowest EE content (0.72 ± 0.14 %), while *Gentiana kurro* had the highest (2.54 ± 0.02 %, $P<0.05$). Ash content was lowest in *Cyclolepis genistoides* and highest in *Gallaniam afghanica*.

The data of carbohydrate fractions, including starch, neutral detergent fiber (NDF), acid detergent fiber (ADF), and crude fiber (CF), are shown in Table (IV). The CF contents s ranged from 20 % to 45 %, with the highest (45.0 ± 0.9%, $P<0.05$) in *Launaea arborescens* and the lowest (20.0 ± 2.5 %) in *Peganum harmala*. The content of NDF was highest ($P<0.05$) in *Launaea arborescens* (69.1 ± 2.3 %) and lowest in *Gentiana kurro* (33.1 ± 0.7 %). Rangeland forage ADF concentrations varied from 23.07 % to 55.02 %, with the highest in *Artemisia scoparia* (55.0 ± 1.0 %) and lowest in *Peganum harmala* (23.0 ± 1.0 %). Starch content was highest in *Cylindropuntia ramosissuma* (3.6 ± 0.1 %) and lowest in *Rhanterium epapposum* (2.33 ± 0.1 %).

Table III. Proximate Analysis (Mean ± S.D) of rangeland species grazed by small ruminants in Surab region Giddar, Marap and Dasht

Botanical names	% on dry matter basis			
	DM%	CP	E.E	Ash
Lycium edgewarthii	93.80^{ab} ± 0.30	8.36^{bc} ± 0.08	1.15^{e} ± 0.06	5.79^{g} ± 0.17
Rhanterium epapposum	93.49^{ab} ± 0.89	7.46^{c} ± 0.275	0.77^{f} ± 0.03	9.46^{ef} ± 0.68
Astragalus Hyrcanus	94.78^{a} ± 0.42	8.86^{bc} ± 0.08	0.91^{de} ± 0.05	6.45^{fg} ± 0.44
Nepeta juncea	94.19^{ab} ± 0.35	6.90^{ef} ± 0.32	1.47^{bc} ± 0.07	18.00^{b} ± 1.00
Sophora mollis	93.38^{ab} ± 0.48	12.56^{a} ± 0.40	1.85^{b} ± 0.16	8.00^{ef} ± 0.99
Paspalum vaginatum	94.36^{ab} ± 0.79	6.26^{de} ± 0.25	1.63^{bc} ± 0.22	15.16^{bc} ± 1.22
Cylindropuntia ramosissuma	93.11^{ab} ± 0.34	6.88^{cd} ± 0.28	0.72^{f} ± 0.14	6.38^{fg} ± 0.53
Haloxylon griffithii	94.03^{ab} ± 0.45	11.78^{ab} ± 0.21	1.48^{bc} ± 0.07	12.24^{cd} ± 1.08
Artemisia scoparia	93.53^{ab} ± 0.45	6.73^{cd} ± 0.17	1.28^{cd} ± 0.06	15.64^{bc} ± 0.57
Gallaniam afghanica	95.24^{a} ± 0.65	5.27^{ef} ± 0.27	1.34^{cd} ± 0.15	31.16^{a} ± 1.25
Gentiana kurro	93.40^{ab} ± 0.52	11.81^{ab} ± 0.22	2.54^{a} ± 0.02	10.96^{de} ± 0.55
Peganum harmala	91.15^{b} ± 0.74	12.60^{a} ± 0.40	2.07^{b} ± 0.06	10.60^{de} ± 0.04
Cousinia stocksi	93.55^{ab} ± 0.50	5.78^{ef} ± 0.19	1.35^{cd} ± 0.04	12.36^{cd} ± 0.51
Launaea arborescens	93.12^{ab} ± 1.02	6.73^{cd} ± 0.26	1.33^{cd} ± 0.12	5.56^{g} ± 0.40
Cyclolepis genistoides	93.11^{ab} ± 1.16	5.48^{ef} ± 0.43	1.15^{e} ± 0.04	4.80^{h} ± 0.43
Level of significance	P<0.05	P<0.05	P<0.05	P<0.05

DISCUSSION

FARMER DEMOGRAPHY AND GRAZING PREFERENCE

Among the surveyed farmers, 40% had attained only primary-level education, indicating a generally low educational profile. This aligns with the overall literacy context of Balochistan, where the literacy rate (54.5%) remains below that of other provinces, including Punjab (66.3%), Sindh (61.8%), and Khyber Pakhtunkhwa (55.1%) (1). Literacy serves as a critical driver for the acquisition, interpretation, and dissemination of knowledge and information, and is widely recognized as a prerequisite for both individual advancement and broader socio-economic development. In the agricultural context, education enhances farm productivity by improving the quality of labor, facilitating the adoption of modern technologies, and enabling better farm management decisions. Farmer education is central to agricultural development in changing environments (20). Therefore, the low literacy levels among livestock farmers are likely linked to lower productivity and the region's high poverty levels.

The herd composition in Surab shows a clear preference for sheep and goats, driven by the mountainous terrain and extreme temperatures-sheep being more cold-tolerant and goats more heat-tolerant. Sheep are dominant, likely due to better adaptation to winter conditions. Feeding is mainly grazing-based, with limited supplementation from fodder and crop residues. The low use of concentrates is likely due to high cost and limited availability, compounded by low farmer literacy, which may restrict understanding of balanced feeding (21). The importance of small ruminants for milk production explains the relatively greater care given to them compared to other livestock.

Most farmers preferred a morning-to-evening grazing schedule, while noon-to-evening grazing was least common, indicating an effort to maximize grazing time and nutrient intake from rangelands. As noted by Ramirez (22), shrubs and trees are often preferentially grazed due to their higher nutritional value and their role in supplementing low-quality grasses. The findings confirm intensive use of rangelands, particularly by sheep and goats, within sedentary farming systems that depend heavily on these resources. While rangelands generally meet maintenance requirements, forage availability and quality vary with rainfall, grazing pressure, and other environmental factors.

IDENTIFICATION AND ANIMAL PREFERENCE OF RANGELAND SPECIES

Rangelands of Balochistan support a diverse mix of grasses, herbs, and shrubs, structured by climatic gradients and soil characteristics. The results reflect the heterogeneous nature of Balochistan's rangelands, where vegetation composition is shaped by climate and soil conditions. The dominance of

shrubs and herbs indicates adaptation to arid environments and their importance in small ruminant diets. Similar studies have shown that rainfall and aridity strongly influence vegetation patterns across the region. For instance, desert vegetation in the south, shrub-dominated communities (Haloxylon and Artemisia) in central areas, and grasslands (Cymbopogon–Chrysopogon) in the north (23). Although Hussain and Durrani (24) studied on composition of rangelands near Surab, differs from the present findings. Thus, this study provides site-specific evidence on fifteen forage species, contributing to a better understanding of plant use by grazing sheep and goats in the area.

Palatability was assessed under free-grazing conditions, where sheep and goats selected forage without restriction. It reflects animal preference based on taste, texture, and plant composition, with animals generally avoiding species that are fibrous, spiny, or rich in secondary compounds (25, 10). In this study, *Peganum harmala, Galium afghanicum, Gentiana kurroo, Nepeta juncea, Artemisia scoparia,* and *Cousinia stocksii* were highly palatable, likely due to their tender structure and lower fiber content. *Sophora mollis, Astragalus hyrcanus, Paspalum vaginatum, Cylindropuntia ramosissima, Haloxylon griffithii, Launaea arborescens,* and *Cyclolepis genistoides* were moderately palatable, possibly due to coarser texture or the presence of anti-nutritional compounds. *Rhanterium epapposum* and *Lycium edgeworthii* were rarely consumed, indicating low palatability associated with woody or spiny traits. Overall, variation in palatability reflects the balance between nutritional value and plant defense mechanisms, influencing grazing behavior. Effective grazing management is therefore essential to conserve highly palatable species and sustain rangeland productivity.

CHEMICAL COMPOSITION OF RANGELAND PLANTS

An essential measure of the availability of key nutrients for grazing animals is the DM content of forages. Dry matter (DM) content ranged from 93.11 to 95.24% among the studied species. The highest DM was recorded in *Galium afghanicum* while the lowest was observed in *Cylindropuntia ramosissima*. These values are higher than those reported by Hussain and Durran (9) for several grasses, including *Tetrapogon villosus* and *Pennisetum orientale.* Higher DM content generally reflects greater biomass and nutrient density. However, it does not necessarily indicate superior nutritional quality, as plant structure and composition also influence forage value.

In case of crude protein (CP) contents, the maximum value in *Peganum harmala* and *Sophora mollis*, indicate their importance as protein-rich forage. The high CP in *Sophora mollis* is likely due to its leguminous nature and nitrogen-fixing ability (26). Most species exceeded the minimum 7–8% CP required for proper rumen function (27), although seasonal variation may affect availability. Lower CP in some species may limit animal performance during critical stages such as lactation, but overall, the forage appears adequate in protein.

Ether extract (EE) was highest in *Gentiana kurroo*, suggesting a higher energy contribution, while *Cylindropuntia ramosissima* showed the lowest EE, indicating limited energy value. These findings are consistent with reports that shrubs generally contain higher EE than grasses (9).

Ash content, representing the mineral fraction, varied among species, with the highest in *Galium afghanicum* and the lowest in *Cyclolepis genistoides*. Variation in ash content may be influenced by environmental factors such as drought, which can increase mineral concentration (28). Overall, the results indicate variability in mineral composition across rangeland species, highlighting the need for detailed mineral profiling.

The data of CF, NDF, ADF and starch is presented in Table IV. Forage NDF content has a direct impact on animal performance and is essential for preserving the rumen's pH stability through saliva production. However, dietary NDF above 55 %, can reduce feed intake (29). In the present study, Neutral detergent fiber (NDF) content varied markedly among species, ranging from 33.1 to 69.1 % in the species with the highest structural fiber content, indicating substantial variation in cell wall composition. Species with lower NDF values are likely to support higher voluntary dry matter intake, whereas those with elevated NDF concentrations may constrain intake due to rumen fill effects, despite their availability in the rangeland. This suggests that intake potential among the studied species is species-specific rather than uniformly high.

Table IV. Carbohydrate fraction (Mean ± S.D) of rangeland species grazed by small ruminants in Surab region Giddar, Marap and Dasht

Botanical name	% on dry matter basis			
	CF	NDF	ADF	Starch
Lycium edgewarthii	35.1^{d} ± 1.0	63.5^{bc} ± 2.3	46.2^{bc} ± 1.0	2.36^{fg} ± 0.1
Rhanterium epapposum	35.2^{cd} ± 1.0	66.4^{abc} ± 1.6	43.4^{cd} ± 0.5	2.33^{fg} ± 0.1
Astragalus Hyrcanus	39.2^{bc} ± 1.0	67.9^{ab} ± 0.9	51.8^{ab} ± 1.2	2.47^{cd} ± 0.2
Nepeta juncea	41.2^{abc} ± 0.6	68.7^{a} ± 1.5	47.3^{bc} ± 1.4	3.54^{a} ± 0.1
Sophora mollis	23.2^{e} ± 0.6	46.5^{e} ± 1.5	32.6^{e} ± 1.5	3.43^{ab} ± 0.3
Paspalum vaginatum	35.8^{cd} ± 0.2	62.4^{bc} ± 1.6	42.4^{d} ± 0.5	3.45^{ab} ± 0.1
Cylindropuntia ramosissuma	39.3^{bc} ± 1.4	68.1^{a} ± 2.8	54.7^{a} ± 1.5	3.60^{a} ± 0.1
Haloxylon griffithii	28.9^{de} ± 1.0	53.3^{de} ± 1.5	35.3^{de} ± 0.5	3.40^{ab} ± 0.1
Artemisia scoparia	42.3^{ab} ± 1.1	65.8^{abc} ± 1.8	55.0^{a} ± 1.0	3.18^{bc} ± 0.1
Gallaniam afghanica	33.0^{cd} ± 0.9	49.6^{de} ± 1.5	40.8^{cd} ± 1.2	2.75^{de} ± 0.1
Gentiana kurro	22.8^{e} ± 1.2	33.1^{f} ± 0.7	26.0^{f} ± 1.0	2.30^{g} ± 0.2
Peganum harmala	20.0^{f} ± 2.5	33.5f ± 1.2	23.0^{f} ± 1.0	2.57^{ef} ± 0.1
Cousinia stocksi	44.0^{a} ± 1.0	67.6^{ab} ± 2.5	52.2^{ab} ± 0.7	3.10^{bc} ± 0.1
Launaea arborescens	45.0^{a} ± 0.9	69.1^{a} ± 2.3	51.0^{ab} ± 0.8	2.62 ^{cd} ± 0.1
Cyclolepis genistoides	38.7^{bc} ± 1.3	64.9^{abc} ± 1.6	46.1^{bc} ± 1.0	2.40^{g} ± 0.0
Level of significance	P<0.05	P<0.05	P<0.05	P<0.05

Fiber fractions were closely linked to digestibility and intake. ADF content was highest in *Artemisia scoparia*, indicating a larger proportion of cellulose and lignin and thus a lower potential digestibility compared to the lowest ADF measured in *Peganum harmala*. Similarly, higher NDF and ADF in grasses than shrubs (9) suggests that species with elevated structural fiber may limit voluntary intake due to rumen fill effects, whereas species with lower fiber can better support digestible dry matter intake. These differences indicate that intake and digestibility potential are species-dependent, emphasizing the value of maintaining a mix of forage types in grazing systems.

Starch represents a readily fermentable carbohydrate and an important source of rapidly available energy for small ruminants, particularly in extensive grazing systems where dietary energy supply is often constrained by high fiber content of forages. In the present study, starch content was highest in *Cylindropuntia ramosissima*, indicating a comparatively greater contribution to dietary energy density relative to most fibrous rangeland species. Reported starch concentrations in native rangeland plants are generally low, as energy is predominantly supplied through structural carbohydrates; therefore, forages with relatively higher starch levels may provide a nutritional advantage by supporting rumen microbial activity and animal energy balance (30). The higher starch observed in *Cylindropuntia ramosissima* suggest that this species may partially compensate for the low digestible energy typically associated with arid-zone vegetation, particularly during periods of increased physiological demand, such as growth, late gestation, or early lactation. However, the contribution of starch to animal performance must be interpreted in conjunction with overall diet composition, intake level, and fiber fractions, as excessive reliance on a single forage source may limit balanced nutrient supply (30).

Collectively, these results indicate that rangeland species differ in their palatability, fiber composition, and energy content, all of which influence digestibility, voluntary intake, and nutritional adequacy for grazing sheep and goats. Maintaining a heterogeneous plant community and managing grazing pressure are therefore critical for optimizing forage utilization and sustaining rangeland productivity.

CONCLUSION

This study finding led to the conclusion that livestock farmers' animal husbandry and feeding methods at research area were inadequate for producing meat and milk in a healthy manner. It is also state that surab region has most preferred rich nutrients forage species plants grazed by small ruminant that can supply basic nutrients like protein , Crude fiber (ADF and NDF) that could satisfy the need of small

ruminant under grazing condition . Hence, it is proposed that supplementation of concentrate with protein deficient plant forages is imperative under grazing condition to enhance the productivity of animals.

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Author s' contributions:

SY Conducted the research, experimental work and data collection; BC Conceptualized and supervised the study; IBM Analysis of results; NB and SM Write up and experimental support.

Declaration of generative AI-Assisted Tools:

No AI-assisted tools were used.

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