Assessment of Palatability and Grazing Preferences Under Changing Climate: A Case Study of Plant Species in District Karak, Pakistan

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This research investigates the palatability and grazing preferences of various plant species under changing climatic conditions in District Karak, Pakistan. The study categorizes plants into different palatability classes and examines grazing preferences among various animals to identify preferred plant forms and assess the availability of palatable species in the region. Out of 205 plant species studied, the distribution of palatability was as follows: 58 species (28.29%) were classified as non-palatable, 82 species (40%) were palatable, 29 species (14.14%) were highly palatable, 10 species (4.87%) were moderately palatable, 12 species (5.85%) were less palatable, and 13 species (6.34%) were rarely palatable. Grazing preferences indicated that goats consumed 101 species (49.26%), sheep grazed on 93 species (45.36%), and cows fed on 56 species (27.31%). Among the plant parts, whole plants of 82 species (40%) were favored, leaves of 53 species (25.85%) were preferred, and inflorescences or flowers of 6 species (3%) were also consumed. Regarding plant forms, animals preferred the fresh form of 100 species (48.7%), followed by the dry form of 41 species (20.7%), and both fresh and dry forms of 24 species (11.7%). The variability in plant palatability impacts both animal husbandry and agriculture, highlighting the importance of targeted conservation efforts. Particularly in areas with limited availability of palatable species, conservation is essential, especially during periods of low plant availability.

Keywords: Palatability; Animal Preferences; Fresh and Dry Plant Parts; Grazing; Conservation.

Introduction:

Palatability is defined by plant scientists as the combination of a plant's chemical composition, structural attributes, and the availability of other plant species within a pasture or rangeland [1]. Peters (2017) [2] highlights that plant habitats are increasingly disturbed by overgrazing and browsing, which affects the abundance, diversity, and distribution of plants in these areas [3]. Factors such as leaf water content, nitrogen levels, and carbon content can both positively and negatively influence palatability [4]. Heady (1966) [5] notes that herbivory plant selection depends on various factors, including the plant's physiological state, related species, habitat conditions, climatic factors, and overall palatability. Animal preferences are also shaped by characteristics such as plant morphology, mineral content, phenology, and the presence of secondary metabolites [1]. Phenological factors can affect an animal's ability to tolerate certain plants due to variations in the concentration and accumulation of specific components [6]. Peters (2017) [2] found that grazing animals generally prefer fresh plants, which offer a range of chemical and physical attributes that make them more attractive in their natural state.

Effective range management strategies are vital in the context of climate change and must consider multiple factors, including plant preference value, range health, forage availability, preservation of palatable species, and long-term utilization [7]. However, cattle often selectively graze specific plant species while neglecting other available forage. As climate change continues to alter plant species composition and productivity, understanding animal preferences and palatability is crucial for developing resilient ecosystems. This study aims to explore these factors in the District Karak region, investigating the complex interactions between plant species, grazing patterns, and ecosystem sustainability.

Objectives

District Karak, a key grazing area for livestock, is experiencing changes in plant species composition and productivity due to climate change, which affects animal palatability and grazing preferences. Rising temperatures and shifting precipitation patterns are altering plant distribution and abundance, making it essential to assess the palatability and grazing preferences of plant species in this region. This study aims to provide valuable insights into these dynamics, helping to develop climate-resilient grazing management strategies that balance the needs of local communities, livestock, and the environment.

Materials and Methods

Research Area:

The research area is situated between 32°47' and 33°28' north latitude and 70°30' and 71°30' east longitude. It is bordered to the north by Tehsil Banda Daud Shah and to the southeast and southwest by Tehsil Takht-e-Nasrati and Bannu (Figure 1). The climatic conditions are extreme, with hot summers and very cold winters. The highest recorded temperatures in June range from 38°C to 44°C, while January temperatures range from 5°C to 10°C. Winter precipitation occurs over several weeks, while summer rains are characterized by thunderstorms that often cause flash floods (Table 1). The soil is predominantly clay, sandy, or stony, with rare instances of fertile loamy soil (Khan et al., 2013) [8]. The region faces significant ecological challenges, including deforestation, overgrazing, soil erosion, salinity, and water scarcity, all exacerbated by climate change.

Field Survey and Data Collection:

The study was conducted over two years (2022 and 2023), with observations from spring to summer and from summer to winter. Daily grazing preferences of individual animals were

monitored across various plant species, plant parts, and plant conditions to quantify plant palatability. Geographic coordinates, including latitude, longitude, and altitude, were recorded using GPS (Global Positioning System) to accurately locate and revisit each study site.

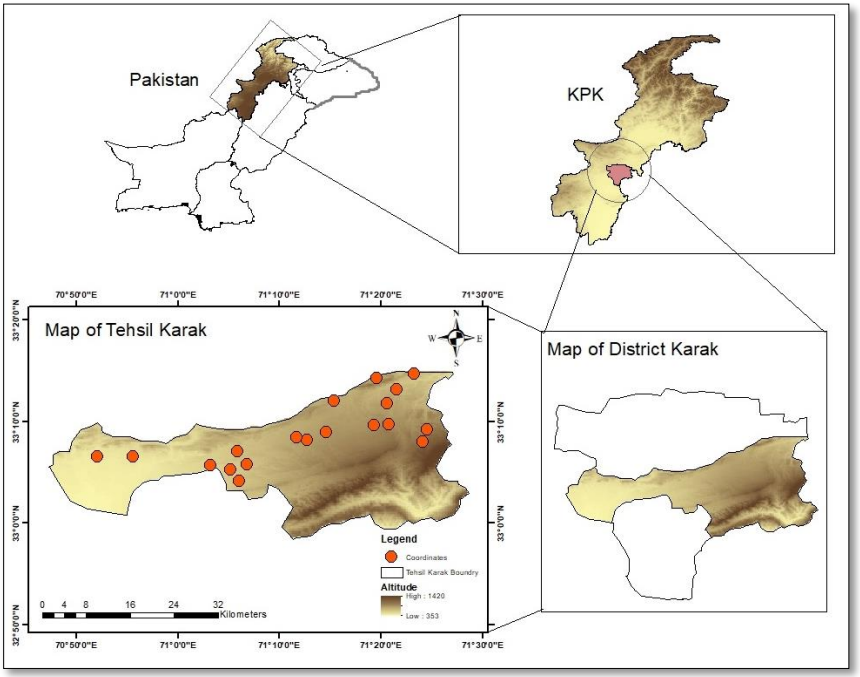

Figure 1: Study Region - District Karak, Pakistan.

Table 1: Average climatic data of Tehsil Karak for the year 2021-2023.

Months	Temperature C°		Humidity (%)		Rainfall	Soil Temperature	Wind Speed
	Max	Min	Max	Min	(mm)	C° Average	Km/h
January	20.22	5.44	76.54	36.34	28.23	8.03	2.8
February	22.80	8.20	78.49	44.20	39.10	10.14	3.00
March	29.23	14.10	75.00	36.02	37.12	14.33	3.6
April	34.30	18.58	68.32	30.42	34.56	20.11	5.2
May	39.32	23.42	60.66	30.53	32.62	23.27	5.6
June	39.62	26.10	61.96	33.89	74.24	26.42	5.9
July	40.44	25.76	70.33	37.86	125.74	26.77	5.5
August	40.66	24.92	74.76	41.46	107.2	24.37	4.00
September	37.47	22.00	76.31	39.32	59.33	23.49	3.8
October	33.55	17.66	71.44	36.56	13.98	22.09	3.7
November	27.81	11.21	70.96	36.77	5.80	15.10	3.2
December	22.80	6.87	74.32	35.90	14.48	8.96	2.9
Mean	32.35	17.02	71.59	36.60	47.7	18.59	4.1

Source: District Director Office of Agriculture Extension, Karak.

Grazing and Browsing:

Various animals, including goats, camels, cows, and sheep, were studied to determine their grazing preferences, as these species exhibit distinct plant preferences. Each animal responded differently to human presence; for instance, it was possible to identify their

preferred grazing areas from a few meters away. Some animals were equipped with radio transmitters to facilitate their tracking and observation at any time. According to Hussain and Mustafa (1995) [9], these evaluations were instrumental in establishing a food choice or palatability index for the observed edible plants.

Palatability Classes:

Following Hussain & Durani (2022) [3], plants were classified into palatable and non-palatable classes.

- **Non-Palatable (NP):** Not at any stage grazed by animals.
- **Highly Palatable (HP):** Types of plants that livestock strongly prefer to eat.
- **Moderate Palatable (MP):** Plant species with average likeness by the livestock.
- **Less Palatable (LP):** Plant species that livestock are less likely to favor.
- **Rarely Palatable (RP):** Plant species only grazed when they had no other option.

Parts of Plants Consumed and their Condition:

The palatable plant species selected based on animal grazing preferences were subjected to a fractional analysis, which categorized the edible components into foliar, aerial, and whole-plant materials. The consumed plant portions were further classified by moisture content into three categories: fresh (high moisture), dry (low moisture), and mixed (a combination of both). This classification facilitated a more detailed investigation into animal grazing preferences and the nutritional properties of the ingested plant materials.

Data Management and Analysis

Data was meticulously compiled, tabulated, and analyzed statistically. Plant specimens collected during the study were dried and preserved for taxonomic identification. This identification was conducted with reference to established literature [10] to ensure accuracy and validity.

Results and Discussion

Palatability and Associated Features

The flora of the study area is grazed by goats, sheep, and cows. The palatability of 205 plant species was documented (Table 2). Among these, 58 species (28.29%) were classified as non-palatable, 82 species (40%) as palatable, 29 species (14.14%) as highly palatable, 10 species (4.87%) as moderately palatable, 12 species (5.85%) as less palatable, and 13 species (6.34%) as rarely palatable. Common non-palatable species included *Asparagus officinalis* L., *Atriplex lasiantha* Boiss., and *Ajuga bracteosa* Wall. Ex Benth., among others. Some non-palatable plants, such as *Ricinus communis*, are used in medicinal applications, like castor oil production, though their fresh leaves can cause adverse reactions such as sneezing and coughing. Plants like *Euphorbia helioscopia*, *Nerium oleander*, and *Ricinus communis* contain bioactive compounds with potential medicinal benefits [12][13]. Despite their toxicity, further research could explore their potential therapeutic uses. Morphological characteristics, growth stages, and chemical composition significantly influence plant acceptability. Unpalatable plants often contain deterrents like tannins, phenolics, and alkaloids, or physical defenses such as thorns and trichomes [14]. Additionally, some non-palatable plants lack essential nutrients or contain anti-nutritional factors that inhibit nutrient absorption, making them less suitable for herbivores [15].

Plant Preference by Animals

The grazing preferences of goats, cows, and sheep revealed that goats grazed on 101 plant species (49.26%), sheep on 93 species (45.36%), and cows on 56 species (27.31%) (Figure

2). These findings align with previous research by Hussain and Mustafa (1995) [16]. Studies by Hussain and Durrani (2022) indicate a general preference for fresh fodder among animals. Goats and sheep, in particular, favor forbs and grasses [3][17]. Grazing and browsing can also alter the morpho-anatomical traits of plants, potentially increasing the abundance of non-palatable species under heavy grazing pressure [1][18]. This shift may result in a higher prevalence of non-palatable species in areas experiencing significant grazing stress.

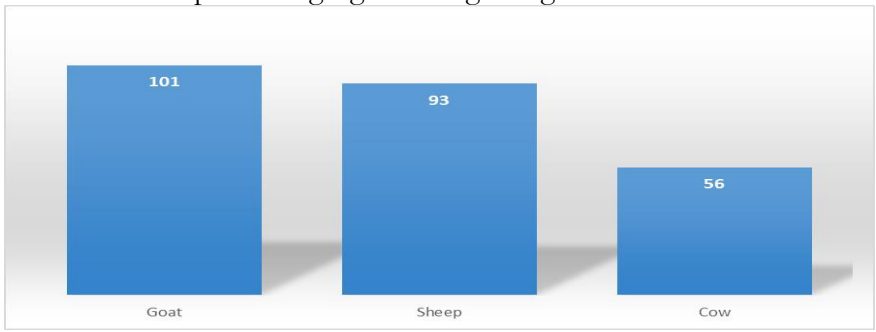

Figure 2: Animal-plant preference relationships in Tehsil Karak, KP, Pakistan.

Differential Palatability of Plant Parts:

Animal preferences varied for different plant parts. The majority of palatable plants were consumed in their entirety, with 82 species (40%) being grazed as whole plants. Leaves were preferred by 25.85% of the species, while inflorescences were the least consumed, making up only 3% of the grazing preferences (Figure 3). Herbivory contributes to plant diversity by influencing both global frequency abundance—referring to the number of species related to herbivory—and spatial variability, where herbivory creates transient refuges for different species. For herbivores to obtain essential nutrients, there must be a sufficient and diverse supply of forage. Proper grazing management is crucial to maintaining a balanced and sustainable fodder environment. Younger plant tissues are generally more resistant to drought compared to older tissues. Water is transferred from older to younger tissues, promoting growth and delaying wilting. Additionally, as plants wilt, starch is converted to sugar, resulting in higher sugar levels and increased palatability.

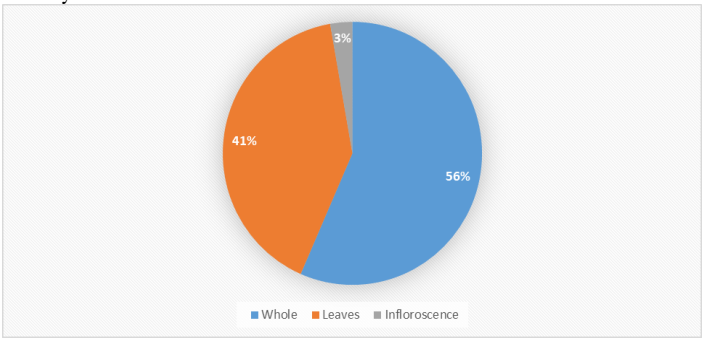

Figure 3: Plant parts preferred by animals in the Karak region.

Plant Condition Preferred by Animals:

Our research findings reveal a clear preference among animals for fresh plant material. Of the plants studied, 100 species (48.7%) were consumed in their fresh form, 20 species (9.7%) in their dry form, and 24 species (11.7%) in both fresh and dry forms (Figure 4). These results are consistent with previous research indicating that animals generally prefer fresh, living tissues.

Grazing significantly enhances the accessibility and availability of live plant tissues while reducing the proportion of dead material. Ungulate grazing efficiency is notably higher when fresh plant materials are available. Seasonal variations in fodder availability are influenced by climate and phenological stages, as observed by Hussain and Durrani (2022) [3]. Their study highlighted that fresh fodder species were crucial for livestock nutrition in the Nasirabad valley. Additionally, Marqueus et al. (2004) [19] identified shrubs as an important source of fresh fodder during periods of scarcity of annual plants. Our observations confirm that many palatable plant species are most abundant during the spring season (March to April), a period characterized by a high availability of fodder. This seasonal peak in palatable species is likely vital for meeting the nutritional needs of livestock during this time.

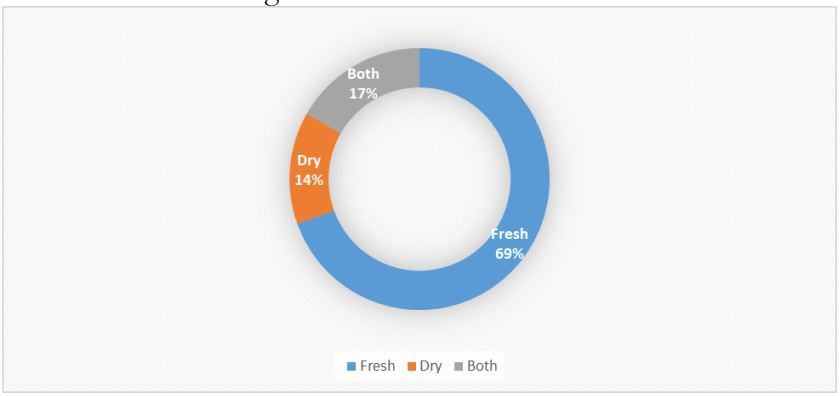

Figure 4: Livestock feeding preferences for fresh and dry fodder in the Karak region.

In the present research study, it was personally observed that during the summer the unavailability of herbs led to an increase in palatability, causing animals to graze on typically non-palatable plant species. This indicates that palatability is dependent on the availability of plant species. Specifically, it was observed that Zizyphus mauritiana Lam. in the plains became highly palatable in the winter but turned less palatable or rarely palatable in the spring, supporting the idea that seasonal variations affect palatability. According to Hickman et al. (2004) [20], variations in plant composition at grazing sites are significantly influenced by animal diversity, which is the primary variable affecting plant species diversity. Badshah et al. (2013) [21] noted that goats like other livestock exhibit nutritional independence as they select high-nutrient plant species in meadows. Two notable plant species in rangelands used for free grazing are Cymbopogon jwarancusa and Dichanthium annulatum (Forssk.) Stapf. Cymbopogon jwarancusa is primarily found in plain areas but is also frequently present in lower hilly regions (Figures 9 and 10). These observations underscore the importance of considering both seasonal and spatial variations in plant species when assessing the palatability and dietary preferences of grazing animals.

Table 2: Palatability classes, Condition of plants, Livestock, and parts used in the Karak Region.

S.NO	Plant Scientific Name	Palatability Classes						Plant Condition			Livestock grazing			Parts used		
	Family wise	Np	P	Hp	Mp	Lp	Rp	Fresh	Dry	Both	Cow	Goat	Sheep	W	L	Inf
	Herbs (Plants)															
(01)	Allium cepa L.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(02)	Allium sativum L.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(03)	Aloe barbadensis Mill.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(04)	Nannorrhops ritchiana (Griff.) Aitchison	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(05)	Asparagus adscendens Roxb.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(06)	Asparagus officnalis Royle.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(07)	Cyperus rotundus L.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(08)	Juncus inflexus Linn.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(09)	Aristida adscensionis Linn.	-	+	-	-	-	-	-	+		+	-	+	+	-	-
(10)	Typha latifolia L.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(11)	Aristida cyanantha Nees ex Steud.	-	+	-	-	-	-	-	+	-	-	-	+	+	-	-
(12)	Avena fatua Linn.	-	-	+	-	-	-	+	-	-	-	+	+	+	-	-
(13)	Avena sativa L.	-	-	+	-	-	-	+	-	-	-	+	+	+	-	-
(14)	Cenchrus biflorus Hook. f.	-	+	-	-	-	-	+	-	-	+	-	-	+	-	-
(15)	Cenchrus setigerus Linn.	-	+	-	-	-	-	+	-	-	+	-	-	+	-	-
(16)	Cenchrus ciliaris Linn.	-	+	-	-	-	-	+	-	-	+	-	-	+	-	-
(17)	Cymbopogon jwarancus (Jones) Schult.	-	-	-	-	+	-	-	-	+	-	+	+	+	-	-
(18)	Chrysopogon aucheri (Boiss.) Stapf	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(19)	Cynodon dactylon (L) Pres.	-	-	+	-	-	-	+	-	-	+	+	+	+	-	-
(20)	Dactyloctenium aegyptium (L.) Willd.	-	-	-	-	+	-	-	-	+	-	+	-	-	-	+
(21)	Desmostachya bipinnata (L.) Stapf.	-	+	-	-	-	-	-	+	-	+	-	-	-	+	-
(22)	Dichanthium annulatum (Forssk.) Stapf	-	-	+	-	-	-	-	-	+	+	-	-	+	-	-
(23)	Echinochloa colona (L.) Link.	-	-	+	-	-	-	-	-	+	-	+	+	-	+	-
(24)	Eleusine compressa (Forssk.)	-	-	+	-	-	-	+	-	-	+	+	+	+	-	-

(25) Eleusine indica (Linn.) Gaertn.	-	-	+	-	-	-	+	-	-	+	+	+	+	-	-
(26) Eragrostis poaoides Beauv.	-	-	+	-	-	-	-	+	-	-	+	+	+	-	-
(27) Eragrostis minor Host.	-	-	+	-	-	-	-	+	-	-	+	+	+	-	-
(28) Hordeum vulgare L.	-	-	+	-	-	-	+	-	-	+	+	+	+	-	-
(29) Imperata cylindrica (Linn.) Raeuschel.	-	+	-	-	-	-	-	+	-	-	+	-	-	+	-
(30) Pennisetum typhoideum (Burm) Stapf.	-	+	-	-	-	-	+	-	-	+	+	+	+	-	-
(31) Pennisetum orientale L. C. Rich.	-	+	-	-	-	-	+	-	-	+	+	+	+	-	-
(32) Phragmites karka (Retz.) Trimn.ex. Steud	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-
(33) Poa annua Linn.	-	-	+	-	-	-	-	-	+	-	+	+	+	-	-
(34) Poa infirma H. B. K.	-	-	+	-	-	-	-	-	+	-	+	+	+	-	-
(35) Polypogon monspeliensis Linn.	-	+	-	-	-	-	-	-	+	+	-	-	-	+	-
(36) Saccharum bengalense Retz	-	+	-	-	-	-	-	-	+	+	-	-	+	-	-
(37) Saccharum spontaneum L.	-	+	-	-	-	-	-	-	+	+	-	-	-	+	-
(38) Sorghum vulgare (L.) Pers.	-	+	-	-	-	-	+	-	-	+	+	+	+	-	-
(39) Setaria viridis (Linn.) P. Beauv.	-	+	-	-	-	-	-	-	+	-	+	+	+	-	-
(40) Tetrapogon villosus L	-	-	-	-	+	-	+	-	-	-	+	-	-	+	-
(41) Triticum aestivum L.	-	-	+	-	-	-	+	-	-	+	+	+	+	-	-
(42) Zea mays L.	-	-	+	-	-	-	+	-	-	+	+	+	+	-	-
(43) Achyranthes aspera L.	-	+	-	-	-	-	+	-	-	+	+	+	+	-	-
(44) Amaranthus graecizans Linn.	-	+	-	-	-	-	+	-	-	+	+	+	+	-	-
(45) Amaranthus spinosus Linn.	-	+	-	-	-	-	+	-	-	+	+	+	+	-	-
(46) Amaranthus viridis L.	-	+	-	-	-	-	+	-	-	+	+	+	+	-	-
(47) Digera muricata (L.) Mart.	-	+	-	-	-	-	+	-	-	-	+	+	+	-	-
(48) Pupalia lappacea (L.) Juss.	-	-	-	+	-	-	-	-	+	-	+	+	-	+	-
(49) Asphadelus tunifolius Cavan.	+	-	-	-	-	-	-	+	-	-	+	-	+	-	-
(50) Cannabis sativa L.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(51) Anethum sowa Roxb.	-	+	-	-	-	-	+	-	-	+	+	+	+	-	-
(52) Coriandrum sativum L.	-	-	-	-	-	+	+	-	-	-	+	+	-	+	-
(53) Daucus carrota L.	-	+	-	-	-	-	+	+	-	-	+	+	-	+	-
(54) Torilis leptophylla (L.) Reichb. f.	-	+	-	-	-	-	-	-	+	-	+	-	-	+	-
(55) Carthamus tinctorius L.	-	+	-	-	-	-	+	-	-	+	+	+	-	+	-
(56) Carthamus oxycantha Bieb	-	+	-	-	-	-	+	-	-	+	+	+	-	+	-
(57) Verbecina enceliodes L.	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-
(58) Centaurea iberica Trevir. ex. spreng.	-	-	-	-	-	+	+	-	-	-	+	+	-	+	-
(59) Conyza Canadensis (Linn.) Cronq.	-	-	-	-	-	+	+	-	-	-	+	-	+	-	-
(60) Echinops cehinatus D. C	-	-	-	-	+	-	+	-	-	-	+	+	+	-	-
(61) Gnaphalium affine D. Don	-	-	-	+	-	-	+	-	-	-	+	+	+	-	-
(63) Helianthus annus L.	-	+	-	-	-	-	+	-	-	+	-	-	-	+	-
(64) Hertia intermedia (Boiss.) O. Ktze.	-	+	-	-	-	-	+	-	-	-	+	+	-	+	-

(65) Inula grantioides Boiss.	-	+	-	-	-	-	+	-	-	-	+	-	-	+	-
(66) Lactuca sativa L.	-	-	+	-	-	-	+	-	-	+	+	+	+	-	-
(67) Lactuca serriole L.	-	-	+	-	-	-	+	-	-	+	+	+	+	-	-
(68) Launaea procumbens (Roxb.) Ramayya	-	+	-	-	-	-	-	-	+	-	+	-	+	-	-
(69) Saussurea heteromalla (D. Don) Hand.	-	+	-	-	-	-	+	-	-	+	-	-	+	-	-
(70) Sonchus asper (L.) Hill.	-	+	-	-	-	-	+	-	-	-	-	-	+	-	-
(71) Taraxacum officinale Webber.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(72) Xanthium strumarium L.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(73) Arnebia griffithii Boiss.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(74) Heliotropium europaeum L.	-	+	-	-	-	-	+	-	-	-	-	+	+	-	-
(75) Heliotropium strigosum Willd.	-	+	-	-	-	-	-	+	-	+	-	-	-	+	-
(76) Onosma hispida Wall.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(77) Brassica campestris Linn.	-	-	+	-	-	-	+	-	-	-	-	+	-	+	-
(78) Brassica napus L.	-	-	+	-	-	-	+	-	-	-	+	+	+	-	-
(79) Brassica repa L.	-	-	+	-	-	-	+	-	-	-	+	+	+	-	-
(80) Brassica oleraceae Linn.	-	-	+	-	-	-	+	-	-	-	+	+	+	-	-
(81) Coronopus didymus (L)	-	-	-	-	+	-	+	-	-	-	+	+	+	-	-
(82) Malcolmia africana (L) R. Br.	-	+	-	-	-	-	-	-	+	-	-	+	+	-	-
(83) Malcolmia strigosa Boiss.	-	+	-	-	-	-	-	+	-	-	-	+	-	+	-
(84) Raphanus sativus L.	-	+	-	-	-	-	+	-	-	-	+	+	-	+	-
(85) Sissymbrium irrio L.	-	+	-	-	-	-		+	-	-	-	+	-	+	-
(86) Cleome viscosa L.	-	-	-	-	+	-	-	-	+	-	-	+	-	+	-
(87) Atriplex lasiantha Boiss.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(88) Chenopodium album L.	-	+	-	-	-	-	-	-	+	-	-	+	+	-	-
(89) Chenopodium murale L.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(90) Kochia prostrate (L) Schrad	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(91) Spinaceae olaraceae L.	-	-	-	+	-	-	+	-	-	-	+	-	-	+	-
(92) Suaeda fruticosa Forssk	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(93) Convolvulus arvensis L.	-	+	-	-	-	-	-	+	-	-	-	-	-	+	-
(94) Convolvulus prostratus Forssok	-	-	-	-	-	+	-	+	-	-	-	-	-	+	-
(95) Evolvulus alsinoides Linn.	-	-	-	+	-	-	+	-	-	-	+	+	+	-	-
(96) Citrullus colocynthis L. Schrad.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(97) Citrullus vulgaris Schrad ex Eckl. & Zeyh	-	+	-	-	-	-	+	-	-	+	+	+	+	-	-
(98) Cucumis melo Linn.	-	+	-	-	-	-	+	-	-	+	+	+	+	-	-
(99) Cucurbita pepo L.	-	+	-	-	-	-	-	-	+	-	+	+	-	+	-
(100) Luffa aegyptica (L) M. J. Rocm	-	+	-	-	-	-	+	-	-	-	+	+	-	+	-
(101) Luffa cylindrica (L) Roem.	-	+	-	-	-	-	+	-	-	-	+	+	-	+	-
(102) Momordica charantia Linn.	-	+	-	-	-	-	+	-	-	-	+	+	+		-
(103) Cuscuta reflexa Roxb.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-

(104) Euphorbia hirta Forssk.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(105) Euphorbia helioscopia L.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(106) Euphorbia dracunculoides Lam.	-	+	-	-	-	-	+	-	-	-	+	+	+	-	-
(107) Euphorbia prostrata Ait.	-	-	-	-	-	+	+	-	-	+	-	-	+	-	-
(108) Fumaria indica (Haussk.) Pugsley	-	+	-	-	-	-	+	-	-	-	-	+	-	+	+
(109) Ajuga bracteosa Wall. Ex. Benth	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(110) Mentha arvensis L.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(111) Mentha longifolia (L.)	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(112) Otostegia limbata (Benth.) Boiss.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(113) Salvia aegyptica L.	-	+	-	-	-	-	+	-	-	+	-	-	+	-	-
(114) Salvia moorcroftiana Wallich ex Benth.	-	+	-	-	-	-	+	-	-	+	-	-	+	-	-
(115) Salvia santolinifolia Boiss. Diagn.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(116) Abutilon indicum (Linn.) Sweet.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(117) Malva neglecta Wallr.	-	+	-	-	-	-	+	-	-	+	+	+	+	-	-
(118) Malva parviflora L.	-	+	-	-	-	-	+	-	-	+	+	+	+	-	-
(119) Boerhavia procumbens Bank ex Roxeb.	-	-	-	-	+	-	+	-	-	+	+	+	+	-	-
(120) Cistanche tubulosa (Schrenk.) Hook. f.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(121) Orobanche ramosa L.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(122) Oxalis corniculata L.	-	-	-	-	-	+	+	-	-	-	+	-	+	-	-
(123) Arachis hypogaea L.	-	-	-	+	-	-	+	-	-	+	+	+	-	+	-
(124) Astragalus psilocentros Fisch.	-	+	-	-	-	-	-	-	+	-	+	-	+	-	-
(125) Cicer arietinum L.	-	+	-	-	-	-	-	-	+	+	+	+	+	-	-
(126) Lathyrus aphaca Linn.	-	-	-	-	-	+	+	-	-	-	+	+	+	-	-
(127) Medicago laciniata L.	-	+	-	-	-	-	+	-	-	+	+	+	+	-	-
(128) Midicago polymorpha Linn	-	+	-	-	-	-	+	-	-	+	+	-	+	-	-
(129) Melilotus indicus L.	-	-	+	-	-	-	-	-	+	-	+	+	+	-	-
(130) Vicia sativa L.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(131) Plantago lanceolata L.	-	+	-	-	-	-	-	-	+	-	+	+	+	-	-
(132) Plantago ovata Frossk.	-	+	-	-	-	-	-	-	+	-	+	+	+	-	-
(133) Rumex dentatus (Meisn.) Rech. f.	-	+	-	-	-	-	+	-	-	+	-	-	+	-	-
(134) Ranunculus arvensis L.	-	-	-	-	-	+	+	-	-	+	-	-	+	-	-
(135) Ranunculus murathus L.	-	+	-	-	-	-	+	-	-	+	-	-	+	-	-
(136) Ranunculus sceleratus L.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(137) Kickxia ramosissima (Wall) Jan.	-	+	-	-	-	-	+	-	-	-	-	+	+	-	-
(138) Verbascum thapsus Linn.	-	-	-	+	-	-	+	-	-	-	+	+	-	+	-
(139) Capsicum annum L.	-	-	-	+	-	-	-	-	+	-	+	-	-	+	+
(140) Lycopersicum esculentum L.	-	+	-	-	-	-	-	+	-	-	+	+	+	-	-
(141) Solanum melongena L.	-	+	-	-	-	-	-	+	-	+	+	+	+	-	-
(142) Solanum nigrum L.	-	-	+	-	-	-	-	+	-	-	+	+	+	-	-

(143) Solanum surattense Burm. f.	-	+	-	-	-	-	-	-	+	-	-	+	+	-	-
(144) Fagonia cretica L.	-	-	-	-	+	-	+	-	-	-	-	-	+	-	-
(145) Peganum harmala L.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(146) Tribulus terrestris L.	-	-	+	-	-	-	+	-	-	-	+	+	+	-	-
Total	**35**	**63**	**23**	**08**	**09**	**11**	**70**	**16**	**24**	**46**	**76**	**75**	**76**	**31**	**03**
Shrubs (Plants)															
(01) Saccharum bengalense Retz	-	+	-	-	-	-	-	+	-	-	+	-	+	-	-
(02) Saccharum spontaneum L.	-	-	-	-	-	+	-	+	-	-	+	-	+	-	-
(03) Rhazya stricta Dcne.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(04) Nerium indica Mill.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(05) Calotropis procera (Wild) R. Br.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(06) Periploca aphylla Decne.	-	-	-	-	-	+	+	-	-	+	+	+	-	+	-
(07) Paulicaria glaucescens (Bois.) Jaub	-	+	-	-	-	-	+	-	-	+	+	-	-	+	-
(08) Aerva Javanica (Burm. f. Juss. Ex Schult.)	-	-	-	-	-	+	-	+	-	+	-	+	-	+	+
(09) Capparis spinosa L.	-	+	-	-	-	-	-	+	-	+	+	-	+	-	-
(10) Maytenus royleanus Wall.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(11) Haloxylon griffthii Moq	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(12) Ricinus communis L.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(13) Abutilon bidentatum A. Rich.	-	+	-	-	-	-	+	-	-	-	+	-	-	+	+
(14) Tinospora cordifolii (DC.) Meris	-	-	-	+	-	-	+	-	-	-	+	+	-	+	-
(15) Marabilis jalapa Linn.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(16) Jasminum officinale Linn.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(17) Jasminum humile Linn.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(18) Alhagi maurorum Medik.	-	-	-	-	-	+	+	-	-	-	-	-	-	+	-
(19) Lespedeza juncea Linn.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(20) Segeratia thea (Osbeck)	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(21) Rosa indica L.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(22) Salvadora oleoides Decne.	-	-	-	-	+	-	+	-	-	-	+	+	-	+	-
(23) Dodonaea viscosa L.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(24) Datura metel L.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(25) Solanum incanum L.	-	+	-	-	-	-	+	-	-	-	+	+	-	+	-
(26) Withania coagulans Dunal.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(27) Withania somnifera L.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(28) Vitex negundo L.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(29) Vitex trifolia L.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(30) Vitis vinifera L.	-	-	-	-	+	-	+	-	-	-	+	-	-	+	-
Total	**18**	**05**	**00**	**01**	**02**	**04**	**08**	**04**	**00**	**04**	**10**	**05**	**03**	**09**	**02**
Tress (Plants)															
(01) Phoenix dactylifera L.	-	+	-	-	-	-	+	-	-	-	+	+	-	+	-

(02) Mangifera indica L.	-	-	-	-	-	+	+	-	-	+	-	-	-	+	-
(03) Cordia myxa L.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(04) Capoaris decidua (Forssk). Edgeworth	-	-	-	+	-	-	+	-	-	-	+	-	-	+	-
(05) Melia Azedarach L.	-	+	-	-	-	-	+	-	-	+	+	-	-	+	-
(06) Acacia modesta Wall.	-	+	-	-	-	-	+	-	-	-	+	-	-	+	-
(07) Acacia nilotica (L.) Delice.	-	+	-	-	-	-	+	-	-	-	+	+	-	+	-
(08) Albizia lebbeck (L.) Benth.	-	+	-	-	-	-	+	-	-	-	+	+	-	+	-
(09) Prosopis farcta (Banks & Sol.) J.F.Macbr	-	-	+	-	-	-	+	-	-	-	+	+	-	+	-
(10) Prosopis juliflora (Sw.) DC.	-	-	+	-	-	-	+	-	-	+	+	+	-	+	-
(11) Ficus carica L.	-	+	-	-	-	-	+	-	-	-	+	+	+	-	-
(12) Ficus palmata Forssk.	-	+	-	-	-	-	+	-	-	-	+	+	+	-	-
(13) Morus alba L.	-	+	-	-	-	-	+	-	-	-	+	+	-	+	+
(14) Morus nigra L.	-	+	-	-	-	-	+	-	-	-	+	+	-	+	-
(15) Eucalyptus globules L.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(16) Eucalyptus lanceolatus L.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(17) Olea ferruginea Royle.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(18) Dalbergia sisso Roxb.	-	-	-	-	+	-	+	-	-	-	+	+	-	+	-
(19) Punica graniatum L.	-	+	-	-	-	-	+	-	-	-	+	-	-	+	-
(20) Zizyihus maurtiana Linn.	-	-	+	-	-	-	+	-	-	+	+	-	-	+	-
(21) Zizyphus nummularia (Burm.f) W. &A.	-	-	+	-	-	-	+	-	-	+	+	-	-	+	-
(23) Zizyphus oxyphylla Edgew	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(24) Eriobotrya japonica (Thunb).	-	+	-	-	-	-	+	-	-	-	+	+	+	-	-
(25) Prunus armeniaca L.	-	+	-	-	-	-	+	-	-	-	+	+	-	+	-
(26) Prunus domestica Linn.	-	+	-	-	-	-	+	-	-	-	+	+	-	+	-
(27) Monotheca buxifolia (falk) A. DC.	-	-	+	-	-	-	+	-	-	-	+	-	-	+	-
(28) Ailanthus altissima Mill.	-	+	-	-	-	-	+	-	-	+	+	-	-	+	-
(29) Tamarix aphylla (L.) Karst.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	**06**	**14**	**05**	**01**	**01**	**01**	**22**	**00**	**00**	**06**	**21**	**13**	**03**	**19**	**01**

Note: Non-palatable (NP), rarely palatable (RP), Low palatable (LP), Moderate palatable (MP), Highly palatable (HP)
Whole plant (W), Leaves (L), and inflorescence (Inf).

According to this study, locals primarily use Zizyphus mauritiana as goat feed in the winter and Acacia modesta in the spring. Qureshi (2014) [22] noted that the preferences of goats and sheep, along with the botanical composition and seasonal availability of forage, change during the growing season. In the studied region, sheep preferred grasses while goats favored bushes, aligning with findings from previous researchers (Qureshi, 2014; Dickinson et al., 2015; Hussain et al., 2023; Ekblom and Gillson, 2010) [22][23][18][24]. Our study revealed significant seasonal variations in plant palatability across different altitudes, with peak palatability observed in the summer. Plant availability strongly influences palatability, and in areas with abundant vegetation, animals select plants based on their needs. Research indicates that during summer, animals may even prefer plants that are generally considered non-palatable. For instance, Euphorbia helioscopia is often unpalatable due to its content of phenolic compounds, alkaloids, and saponins. Conversely, plants such as Cynodon dactylon, Cenchrus ciliaris, and Euphorbia prostrata were found to be highly palatable in the region.

According to Hussain et al. (2023) [18], Cenchrus species are prevalent along field boundaries and heap margins (Figure 10). The availability of alternative forage can influence grazing patterns, with animals sometimes consuming less preferred plants when their preferred choices are not available [15]. While some plants may be toxic if consumed in large quantities, they can provide valuable nutrients when eaten in moderation or mixed with other feeds. In early spring and late winter, livestock show a strong preference for the leaves and shoots of Zizyphus mauritiana, whereas Acacia modesta is favored in mountainous areas during the summer. In plain areas, where plant availability is limited, animals graze on whatever is accessible. Omer et al. (2006) [25] found that food production in dry temperate regions of northern Pakistan peaks in the spring. Cows in the region preferred Saccharum bengalense in the spring and winter, and Dalbergia sissoo in the summer (Figure 8). Local animals show a preference for summer herbs and shrubs over spring grasses and winter trees, which is consistent with findings from Barkhatullah et al. (2015) and Hussain et al. (2023) [1][18]. Studies by Qureshi (2014) [22] and others (Kochare et al., 2018 [26]; Chebli et al., 2023 [27]; Singh et al., 2023 [28]) indicate that saponins, alkaloids, and phenolic compounds in plants often have anti-nutritional effects that decrease palatability. Saliva may interact with tannins and volatile oils to reduce their toxicity. In plains, the grazing season extends from April to October.

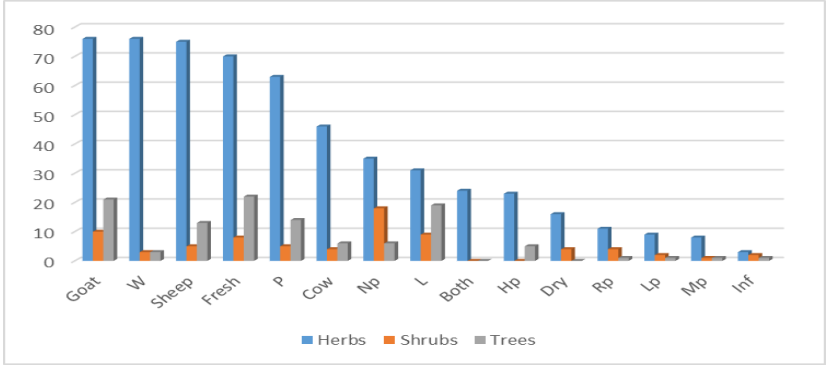

Figure 5: Palatability classes, Condition of plants, Livestock, and parts used in Karak region.

The current study highlights that season, animal type, and plant species all significantly impact plant palatability. To improve the physical condition and productivity of domestic animals in the region, it is recommended to standardize plant palatability according to animal dietary needs. Additionally, climate plays a crucial role in influencing palatability. Factors such as temperature, precipitation, and humidity affect plant growth, nutrient composition, and secondary metabolite production, which, in turn, influence palatability. For example, extreme temperatures and drought conditions can increase the concentration of bitter compounds or reduce nutrient levels in plants, making them less palatable. Conversely, favorable climatic conditions can enhance plant quality and palatability. Therefore, incorporating climate

considerations into the standardization of plant palatability is essential for optimizing the diet and overall health of domestic animals.

Figure 6: Palatability preferences of different animals on different plants

Conclusion:

This study demonstrates that plant palatability is influenced by multiple factors, including animal species, seasonal variations, local ecosystems, weather conditions, and plant species. To improve the physical condition and productivity of domestic animals, it is essential to align plant palatability with the nutritional content of plant species and the specific dietary needs of animals. Additionally, climate plays a critical role, as temperature, precipitation, and humidity significantly impact plant growth, nutrient composition, and the production of secondary metabolites. Therefore, incorporating climate considerations into the standardization of plant palatability is crucial for optimizing animal diets and overall health.

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Conflict of Interest: The authors declare that they have no conflict of interest.

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