



# Seasonal Fluctuations in the Dietary Habits of Indian Crested Porcupine (*Hystrix indica* Kerr) in Pothwar Plateau, Pakistan

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## ABSTRACT

Understanding ecological traits, such as diet analysis of wildlife species, is crucial, especially when the species is categorized as a pest. One such important pest in the agroecosystem of Pakistan is the Indian crested porcupine (*Hystrix indica* Kerr), being a generalized herbivore, the species consumes both natural vegetation and cultivated plants. In the Pothwar Plateau, the species is widely distributed but information about its dietary preference is scanty. Therefore, in the current study, we investigated the diet composition of porcupine in the study area and examined how the season can impact their diet. We performed micro-histology using the faecal pellets collected from the field during fortnightly surveys in the study area. Reference plant samples were also collected from the study areas. The faecal pellets were analyzed in the laboratory using the technique of Micro-histology. Light microscopic slides were prepared and matched with reference samples for identification of the plant species consumed. Results revealed that Indian crested porcupine consumed a diverse range of at least twenty different wild and cultivated plant species. Among wild vegetation, khabbal (*Cyonodon dactylon*) and jujube (*Ziziphus nummularia*) were consumed frequently during all seasons of the year, however, wild jujube was the most frequent wild plant consumed during the summer and spring seasons. Among cultivated plants, chickpea *Cicer arietinum* and mustard *Brassica campestris* were favorites during summer while millet *Agrostis nigricans* and maize *Zea mays* were most frequently consumed during fall and winter. During winter, chickpeas were found to be the most consumed. At the same time, khabbal was consumed the most during autumn. These findings are significant in the context of seasonal variation in the dietary preference of Indian crested .

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## Authors' Contribution

AS and TM designed the study. AS and AJ collected experimental research data and interpreted the results. AS, TM, MM, AJ, SA, MA, and UW assisted in experimental and statistical analysis. AS wrote the research article. MM supervised and revised the manuscript. All authors read and approved the manuscript.

## Key words

*Hystrix indica*, Porcupine, Diet, Micro-histology, Seasonal fluctuations, Pest

## INTRODUCTION

Rodents are a key mammalian group, and highly successful in many environments throughout the world. Over 40% of mammal species have been placed in the order Rodentia. The order Rodentia has 35 families and 534 genera with 2652 living species (ASM Mammal Diversity Database, 2023). The Indian crested porcupine

*Hystrix indica* is one of the largest rodents included among a total of 29 species present across the globe. These are divided into two categories, old-world porcupines, and new-world porcupines (Yang *et al.*, 2013). Old-world porcupines are terrestrial species and there are 11 species of old-world porcupines, all in one family, *Hystricidae*. Out of these 11, three species are native to Africa and the Mediterranean region, while the remaining eight species occur in Asia (Rovie-Ryan *et al.*, 2017). In Pakistan, only one porcupine species is reported; the Indian crested porcupine (Ahmad and Chaudhry, 1977; Khan *et al.*, 2000; Hafeez *et al.*, 2012). This species is widely distributed and found in many areas of the country (Hafeez *et al.*, 2012) including the Pothwar Plateau. The species is listed as the least concern (LC) by the IUCN red list of threatened species (Amori *et al.*, 2021). The Indian crested porcupine is one of the largest rodents, recognized by its body hairs which are modified into sharp and easily removable spines

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called quills (Vishnugurubaran *et al.*, 2021). It is a shy mammal species in nature. It digs deep burrows and is a nocturnal species (Gurung *et al.*, 1996; Akram *et al.*, 2017). The species is reported to have nomadic movements usually, and so it lives in a sub-home range temporarily unless finds a suitable mate (Sever and Mendelsohn, 1991).

The porcupine is considered generalized herbivore (Kelt, 2011; Lovari *et al.*, 2017; Amori *et al.*, 2021), and its diet usually comprises plant material like plant seeds, stem, fruit, and leaves, as they eat plants throughout the cropping cycle (Wyatt *et al.*, 2022). According to studies, rodents consume and destroy food crops yearly that can feed around 200 million people (Stenseth *et al.*, 2003). It is considered an agricultural pest because it damages many important cash crops (Arsalan, 2008; Hafeez *et al.*, 2011; Lovari *et al.*, 2017). In Pakistan, the Indian crested porcupine is recognized as a major vertebrate pest of economically important crops like groundnut *Arachis hypogaea* and maize (Greaves and Khan, 1978; Hafeez *et al.*, 2011). Not only crops, they also feed on a variety of wild plants, grasses, vegetables, fruits, and flowering plants (Khan *et al.*, 2007; Pervez, 2006; Hafeez *et al.*, 2011). It causes huge damage to groundnut, maize, and sugarcane *Saccharum officinarum* in the country. It consumes important vegetables like potato *Solanum tuberosum* and onion *Allium cepa* (Khan *et al.*, 2000; Hafeez *et al.*, 2011).

According to previous studies, porcupines consume various foods as they are generalists and depend upon seasonal availability (Lovari *et al.*, 2017). Due to the wide distribution and pest nature of the species, the dietary habits of Indian crested porcupine in different agroecological regions of the country need to be explored, for its effective management. Keeping in mind such a scenario, the current study aims to investigate the dietary habits of this porcupine species in the Pothwar Plateau.

## MATERIALS AND METHODS

### Study area

The current study was conducted in the Pothwar Plateau, focusing on tehsil Talagan, (32° 55' 47.03" N, 72° 24' 56.99" E). The elevation of the area is 393m (Muhammad *et al.*, 2023), the map of the study area is shown (Supplementary Fig. 1). The Pothwar Plateau comprises a total of 22,500 km<sup>2</sup> area divided into four districts (Chakwal, Attock, Rawalpindi, and Jhelum). In the study area, the summer season is of long duration, while the winter season is dry and of short duration. July and August are the months of highest rainfall, the monsoon season, contributing to the average annual rainfall of 620 mm (Balouch *et al.*, 2016). The mean annual temperature in

the study area in summer is 35°C, while in winter it is 14°C. The study area is semiarid type and rainfall is the major source of irrigation for cultivation of the crops. The main crops cultivated in the Pothwar Plateau, during different seasons of the year, include groundnut, wheat (*Triticum aestivum*), maize, mustard, chickpea, etc. (Taslim *et al.*, 2022). Summer-season crops are cultivated from May to October, while winter-season crops are cultivated from November to April (Balouch *et al.*, 2016). Groundnut is an economically important crop in this region of Pakistan. Munawar *et al.* (2018) reported the lesser bandicoot rat (*Bandicota bengalensis*), Indian gerbil (*Tatera indica*), and short-tailed bandicoot rat (*Nesokia indica*) as major pests of this crop here. Along with other crops, Indian crested porcupine, being a pest, also damages groundnut in the study area (Taslim *et al.*, 2022). The Pothwar Plateau includes subtropical scrub forest containing natural vegetation including mainly phulahi (*Acacia modesta*), kikar (*Vachellia nilotica*), khabbal grass amaltas (*Cassia fistula*), shisham/tahli or Indian rosewood (*Dalbergia sissoo*), jujube, dhrek (*Melia azadarech*), *Eucalyptus* sp., and others (Rehman *et al.*, 2017).

### Study design

The current study was conducted from June 2022 to July 2023. Field surveys for sample collection were carried out fortnightly. Four potential sampling sites were selected (Table I), based on the criteria including the abundance of porcupine burrows, the degree of crop deterioration, and consultation with the local community and the staff of the provincial wildlife department, District Chakwal. The sites were visited for collection of fecal samples of the Indian crested porcupine. A total of 24 collection events in a year were made, with a total sample size of approximately 250. A special attempt was made to collect fresh fecal samples of the species from the field to maximize the accuracy of the results. The collected samples were analyzed in the laboratory using the technique of micro-histology by preparing light microscopic slides of the plant species recovered from the porcupine faecal samples. The slides were matched with those of reference slides to identify the plant species. For this purpose, the reference plant samples were also collected from the same selected sampling sites. The plant species consumed by porcupine were identified and the frequency of occurrence of each plant species was computed during analysis.

### Collection of samples

Fortnightly visits were made to the selected sampling sites for the collection of faecal samples of porcupine. Each visit extended for one day, encompassing diverse subsites to discern the distribution pattern of porcupine burrows.

During each visit, within these subsites, area searches were conducted to locate porcupine burrows, while fresh faecal pellets were collected. Area searches are a type of fieldwork methodology that is frequently used to collect data in wildlife and ecological research. Using this method, a predetermined study area is methodically covered to find, and document target fecal pellets. Notably, on each occasion, distinct piles of faecal pellets were gathered and carefully combined to ensure a representative sample. A total of 480 faecal samples of the species were collected during the study period, with the estimated collection of 20 faecal samples from each visit. Each sampling site was searched for collecting faecal samples of the species. When found in the field, each faecal sample was collected in self-sealing zip-lock polythene bags, along with all details of the site including the geographical coordinates, elevation, and habitat types.

#### *Reference plant collection*

A comprehensive collection of the potential reference plant species was made from the same selected sampling sites during each visit, encompassing approximately 20 plant species, including major cultivated crops and non-cultivated plants, carefully selected based on their deterioration status. The collected plants encompassed a diverse range of species, including maize, chickpea, Indian rosewood, pearl millet *Pennisetum glaucum*, jujube, wheat, groundnut, kikar, fig (*Ficus carica*), pea (*Pisum sativum*), barwa (*Hordeum vulgare*), leafless milk hedge (*Euphorbia caducifolia*), phulai, mustard green and several other non-cultivated plants indigenous to the area. The collection of plants was carried out following their seasonal availability, ensuring that different plant species were collected during different seasons.

#### *Micro-histological studies*

All collected faecal samples of porcupine were analyzed in the laboratory using the technique of microhistology following Williams (1962) and Ward (1970), with little modifications. We prepared two kinds of light microscopic slides for the identification of plant species recovered from the faecal samples of the porcupine; one was faecal material slide, while the other one was a reference plant material slide. For each faecal sample, at least two light microscopic slides were prepared. During analysis, faecal samples were dried first in the oven at 50 °C, overnight. The next day the dried faecal samples were ground into small pieces using a mortar and pestle. Then these ground pieces of faecal samples were homogenized using a homogenizer (ESB-500 Lab homogenizer) to grind smoothly and finely, for 5 min at 3.1 rpm. Then these samples were washed with tap water and again

soaked in the solution mixture of glycerine, ethanol, and distilled water (1:1:1) overnight. The next day we drained the excess solution and added 70% alcohol for 20 min in a beaker. To achieve differentiation, the fragments were treated with a hematoxylin stain. Alcohol gradients (30%, 40%, 50%, 70%, 90%, and 100%) were used to prepare permanent mounts, using Canada balsam. The different light microscopic slides prepared were observed under a camera fitted light microscope (Zeiss 490980-0001-000 Axiolab 5 Upright Microscope) and compared with those of reference slides for identification of plant species consumed by the porcupine. The slides were photographed after comparison with the reference slides.

For preparing reference plant slides, the vegetative parts of plants were dried using plant press, after completely drying and flattening of plants they were ground by hand using mortar and pestle. The sample plant was converted into very fine powder form, after this the plant was soaked in the solution of glycerine, ethanol, and distilled water (1:1:1) overnight, then it was washed with water for about 5 min to remove the excess solution, then the washed plant mixture was homogenized using Vitric homogenizer (ESB-500 Lab homogenizer). The homogenized mixture was then again passed from water for a further five min.

Then, we took a cotton cloth and sieved the mixture, this removed all the excess water, the plant material that remained on the cotton cloth was then soaked in 10% sodium hypochlorite (NaOCl) for about 15 min, after which the plant material along with cotton cloth was shifted in 5% clorox and distilled water solution (1:4) for 20 to 30 min. Now to neutralize the basic effects that were caused by sodium hypochlorite, dilute acetic acid was added. Now for staining purposes, the plant material was transferred to the hematoxylin solution for about 10-15 min, to get the best results, the plant material was dehydrated using alcohol gradients (10%, 25%, 30%, 50%, 70%, 75%). The plant material was soaked in each gradient for about 20-30 min. Now for slide preparation, firstly we placed a drop of Canada balsam on a microscopic slide by using a syringe then with the help of a camel hairbrush we slightly placed the plant material over the slide, then again Canada balsam was added and placed the slide cover over it, gently putting pressure over the slide cover so that the material was spread evenly. We prepared all the microscopic reference slides.

#### *Statistical analysis*

The data were arranged in tabulated form in Excel sheets, descriptive statistics, such as means, standard deviation, and standard error, were calculated directly within Excel. The final comparative mean study was performed using two-way analysis of variance (ANOVA) in SPSS (George and Mallery, 2019).

**Table I. Details of four major sampling sites selected for data collection in the Pothwar Plateau.**

Site	Name of site	Latitude	Longitude	Elevations	Habitat type
1	Bilalabad	N 32.94558	E 72.29131	446 m	Cropland and natural vegetation
2	Dhok Dali	N 32.97052	E 72.31533	447 m	Cropland
3	Pira Fatehal	N 32.90502	E 72.28306	453 m	Cropland and natural vegetation
4	Chowkhandi	N 32.81482	E 72.34616	543 m	Cropland and natural vegetation

## RESULTS

### Physical measurements of faecal samples

All faecal samples (480) collected from the field were transported to the laboratory for analysis. In the laboratory, the length, breadth, and weight of each faecal sample were measured using a digital Vernier caliper and weighing balance (Fig. 1). Mean weight of faecal samples was found to be  $1.89 \pm 0.03$  g, the mean length being  $30.35 \pm 1.13$  mm and mean breadth was  $14.99 \pm 0.67$  mm.

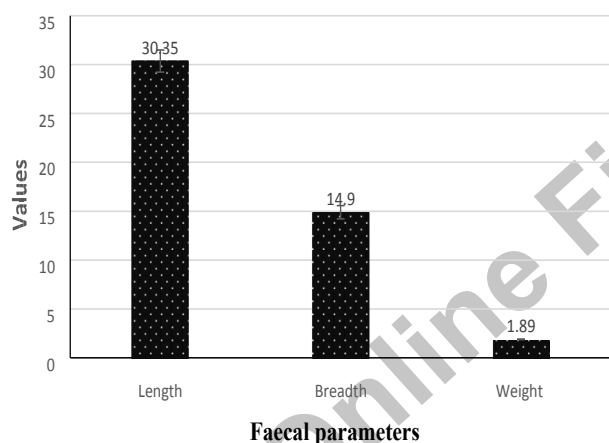


Fig. 1. Physical measurements of the faecal samples of Indian crested porcupine collected from the Pothwar Plateau.

### Diet composition

Faecal analysis revealed that the diet of Indian crested porcupine comprised of at least 20 plant species, including both wild plants as well as cultivated crops (Table II, Supplementary Figs. 2-7) depicting wild vegetation. Leaves of Jujube were the most frequently consumed (23.22%) followed by khabbal grass (12.54%) while gum Arabic tree / Kikar was least consumed (3.06%). Similarly, among cultivated crops, the chickpea was most frequently consumed (18.5%) followed by wheat (13.62%) and millet (12.88%), whereas potato (*Solanum tuberosum*; 4.16%) was the least consumed.

**Table II. Vegetation species consumed by the Indian crested porcupine in the Pothwar Plateau.**

S. N.	Common name/ Scientific names	Mean±SE
<b>Wild/ Natural Vegetation</b>		
1	Gum Arabic tree/ Kikar ( <i>Vachellia nilotica</i> )	3.06±0.44
2	Punarnava/ Itt-Sitt ( <i>Boerhavia diffusa</i> )	4.54±0.98
3	Khabbal grass ( <i>Cynodon dactylon</i> )	12.54±1.39
4	Shisham/Indian rosewood (Leave) ( <i>Dalbergia sissoo</i> )	4.29±0.61
5	Indian rosewood (Stem) ( <i>Dalbergia sissoo</i> )	3.84±0.63
6	Dhab ( <i>Desmostachya bipinnata</i> )	11.91±1.14
7	Phulahi (Leave) ( <i>Acacia modesta</i> )	6.21±0.80
8	Phulahi (Stem) ( <i>Acacia modesta</i> )	6.70±0.81
9	Khuggal/ Rukh/Farash ( <i>Tamarix aphylla</i> )	9.81±1.16
10	Jujube (Leave) ( <i>Zizipus nummularia</i> )	23.22±2.26
11	Jujube (Stem) ( <i>Zizipus nummularia</i> )	5.60±0.89
<b>Cultivated crops</b>		
12	Groundnut/ Peanut ( <i>Arachis hypogea</i> )	9.21±1.61
13	Mustard ( <i>Brassica campestris</i> )	7.53±1.06
14	Chickpea ( <i>Cicer arietinum</i> )	18.55±2.28
15	Fig/ Enjeer ( <i>Ficus carica</i> )	-
16	Pearl millet ( <i>Pennisetum glaucum</i> )	12.88±1.81
17	Pea ( <i>Pisum sativum</i> )	-
18	Potato ( <i>Solanum tuberosum</i> )	4.16±0.64
19	Wheat ( <i>Triticum aestivum</i> )	13.62±1.49
20	Mazie ( <i>Zea mays</i> )	10.44±1.47
21	Unidentified	5.59±0.66

### Seasonal variation

The diet composition of Indian crested porcupine varied seasonally viz. autumn, winter, spring, and summer during the study year (Table III, Supplementary Figs. 2-7). Autumn spans across approximately three months (September to November) in the study area. During this season, the most frequently consumed vegetation species was khabbal grass (19.18±2.91) followed by chickpea (18.78±2.91), while Ittsitt (*Boerhavia diffusa*; 1.21 ± 2.91)

**Table III. Seasonal variation in mean frequency the consumption of natural vegetation and cultivated crops by the Indian crested porcupine in the Pothwar Plateau.**

Food item/ Common name	Autumn	Winter	Spring	Summer
<b>Wild vegetation</b>				
Gum Arabic tree/ Kikar	2.25±2.91	4.292±2.37	4.5±2.91	2.08±1.84
Punarnava/ Itt-Sitt	1.21±2.91	7.333±2.37	5.781±2.91	3.7±1.84
Khabbal grass	19.18±2.91	10.60±2.37	12.37±2.91	11.1±1.84
Indian rosewood (Leave)	2.87±2.91	5.08±2.37	7.28±2.91	3.2±1.84
Indian rosewood (Stem)	3.25±2.91	3.68±2.37	10.47±2.91	1.53±1.84
Dhab	7.56±2.91	13.64±2.37	12.5±2.91	12.38±1.84
Phulai (Leave)	8.62±2.91	8.95±2.37	5.37±2.91	3.93±1.84
Phulai (Stem)	2.46±2.91	7.22±2.37	8.00±2.91	7.57±1.84
Khuggal/ Rukh	9.56±2.91	9.45±2.37	8.531±2.91	10.65±1.84
Jujube (Leave)	16.59±2.91	25.39±2.37	32.75±2.91	20.77±1.84
Jujube (Stem)	5.37±2.91	3.68±2.37	11.37±2.91	4.53±1.84
<b>Cultivated crops</b>				
Groundnut/ Peanut	7.75±2.91	2.37±2.37	6.93±2.91	14.81±1.84
Mustard	2.53±2.91	14±2.37	16.34±2.91	2.137±1.84
Chickpea	18.78±2.91	33.87±2.37	30.75±2.91	4.38±1.84
Fig/ Enjeer	0	0	0	0
Pearl millet	16.09±2.91	8.47±2.37	10.47±2.91	15.21±1.84
Pea	0	0	0	0
Potato	5.40±2.91	4.5±2.37	4.65±2.91	3.26±1.84
Wheat	6.59±2.91	24.58±2.37	24.56±2.91	5.48±1.84
Maize	14.65±2.91	6.29±2.37	7.375±2.91	12.47±1.84
Unidentified	6.31±2.91	6.00±2.37	5.625±2.91	5.05±1.84

was the least consumed. Throughout the winter season (December to February), there was a notable preference for vegetative and cropping plants in terms of consumption. Leading the list of most consumed plants during this period was chickpea (33.87±2.37), followed by mallah/jujube (25.39±2.37), while the least consumed vegetation species during winter was the groundnut (2.37±2.37). The reason behind this is that groundnut have already been harvested in this season. Spring season, spanning from March to April, witnesses a proliferation of both wild and cultivated plants. The most frequently consumed plant during this season was Jujube leaves (32.75±2.91), followed closely by chickpea (30.75±2.91), whereas potato was the least consumed (4.65±2.91). Summer extends from May to September, making it the longest season. The analysis highlights jujube leaves as the most frequently consumed plant (20.77±1.84). It was followed by millet (with a mean frequency of 15.21±1.84), while the Indian rosewood/Shisham stem was the least consumed (1.53 ± 1.84).

Among wild vegetation, khabbal grass and Jujube were consumed during all seasons of the year while among cultivated plants, groundnut and pearl millet were favorite during summer while chickpea and wheat were most frequently consumed during winter and spring (Table III).

## DISCUSSION

Porcupine is considered a generalized herbivore (Kelt, 2011; Lovari *et al.*, 2017). The Indian crested porcupine is an agricultural pest known globally because it consumes and damages many important cash crops (Khan *et al.*, 2007; Hafeez *et al.*, 2011; Lovari *et al.*, 2017) and the species is one of the most important constraints to agricultural production (Aplin *et al.*, 2003). In Pakistan also the species is recognized as a major vertebrate pest of economically important crops like groundnut and maize (Greaves and Khan, 1978; Hafeez *et al.*, 2011). Not only does it destroy crops, but it feeds on a variety of wild plants, grasses,

vegetables, and fruits (Pervez, 2006; Khan *et al.*, 2007; Hafeez *et al.*, 2011). The Pothwar Plateau of Pakistan is a semi-arid zone, having subtropical scrub forest type along with some important cultivated food crops like wheat, and maize. The area is also famous for growing groundnut. The Plateau is home to Indian crested porcupine which is widely distributed across 22,500 km<sup>2</sup> area. Knowing the wild and cultivated crops preferred by Indian crested porcupines in the Pothwar Plateau is important for saving these cash crops from economic losses. Therefore, in the current study, we aimed to investigate the diet composition of porcupine using the technique of micro-histology through analysis of its faecal samples.

Our results revealed a total of 20 different vegetation species, including both wild and cultivated, consumed by Indian crested porcupine in the Pothwar Plateau. These included 11 wild plants and nine cultivated crops. According to our findings, the porcupine most frequently consumed and preferred mallah leaves as well as stem, khabbal grass and dhab (*Desmostachya bipinnata*). The porcupine also damages some important wild tree species including phulahi, shisham, and less frequently kikar. All these tree species are economically important for their wood being used for making furniture. In this regard, porcupine has been found to cause economic loss to furniture wood in the study area. This fact is also verified by some previous studies which reported that porcupine damages trees like Indian jujube, gum arabic tree, longleaf Indian pine (*Pinus roxburghii*) and Indian rosewood on a large scale (Idris and Rana, 2001; Girish *et al.*, 2005). In the current study, across various sites, the average plant consumption remained relatively consistent, owing to the similarity in vegetation composition among these sites. Notable plant preferences emerged, with chickpea, jujube, and khabbal grass consistently standing out as the most consumed plants.

These species exhibited higher frequency of consumption, underscoring their significance within the porcupine diet throughout the study period.

Results of the current study revealed that Indian crested porcupine most frequently consumes some important cultivated cash crops in the study area including wheat, maize, chickpea, groundnut etc. In this respect, the species is causing big economic losses to the food crops every year. These losses need to be quantified and the porcupine needs to be controlled by developing an integrated pest management strategy in the study area. Additionally, one vegetable, potato has also been identified within this dietary spectrum of the porcupine during analysis, however, it could have been eaten passively since potatoe is not cultivated in the study area on a large scale. Some previous studies match the findings of the current

study indicating that Indian crested porcupine causes huge damage to groundnut, maize, and sugarcane in Pakistan, along with consuming important vegetables like potato and onion (Khan *et al.*, 2000; Hafeez *et al.*, 2011). The species also damages wheat and rice on a large scale (Arslan, 2008) and causes great damage to the cultivated area (Mohamed, 2011). Reports from some other regions of the country also show that Indian crested porcupine damages cultivated crops. For example, Hafeez *et al.* (2011) reported that the most consumed crops by porcupines were wheat, mustard, and maize.

Similarly, Hafeez *et al.* (2014) also reported from Thal, Punjab that the potato was least consumed in summer. Khan *et al.* (2021) reported that potato was the least consumed species in summer. Our research concludes the same that potato is the least consumed specie in summer with a mean frequency of  $3.26 \pm 1.84$ . These results confirm to the reported results. The diet composition of Indian crested porcupine varies with the season in the study area, depending upon the availability of the wild and cultivated vegetation. The season has been found to influence the diet of the porcupine as there is variation in the diet in each season especially for the cultivated plants. Among wild vegetation, jujube, khabbal, and Indian rosewood were consumed during all seasons because of their availability. Among cultivated crops, groundnut and pearl millet were frequently consumed during the summer season while chickpea and wheat were the preferred crops during the winter season. Our findings are supported by some previous studies conducted in some other regions of the country; Khan *et al.* (2021) reported from the Azad Jammu and Kashmir area that in winter season the porcupine most frequently consumed a broad-leaved dock (*Rumex obtusifolius*) while in summer, the most frequently consumed plant species was maize in autumn; maize continued to be the most consumed species while in spring and summer, wheat took the lead by being the most frequently consumed cash crop. Our findings suggest similar data that wheat is the most consumed plant during the spring and summer seasons, while millet emerged as the second most consumed plant. In another study Hafeez *et al.* (2015), while analyzing porcupine's stomach contents revealed that kikar was the most consumed tree species during all seasons of the year. In the current study, similar findings have been revealed, although with much lower frequency. Nonetheless, kikar remains a preferred plant in the porcupine diet. The fluctuations witnessed in dietary preference during all four seasons of the year, particularly concerning cultivated plants, serve as a compelling confirmation of the undeniable role that seasonal factors play in shaping the porcupine's feeding behavior.

## CONCLUSION

The current study concludes that Indian crested porcupine consumes both wild and cultivated crops in the Pothwar plateau, notable wild plants consumed include, jujube, khabble grass, shisham, and phulahi while among cultivated crops the porcupine most frequently consumed wheat, chickpea, groundnut and millet, depending upon their availability during different seasons. Our findings also highlight that the porcupine poses an increasing risk as an agricultural pest in the area due to its dietary preferences.

## DECLARATIONS

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### Supplementary material

There is supplementary material associated with this article. Access the material online at: <https://dx.doi.org/10.17582/journal.pjz/20240501125036>

### Statement of conflict of interest

The authors have declared no conflict of interest.

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## Supplementary Material

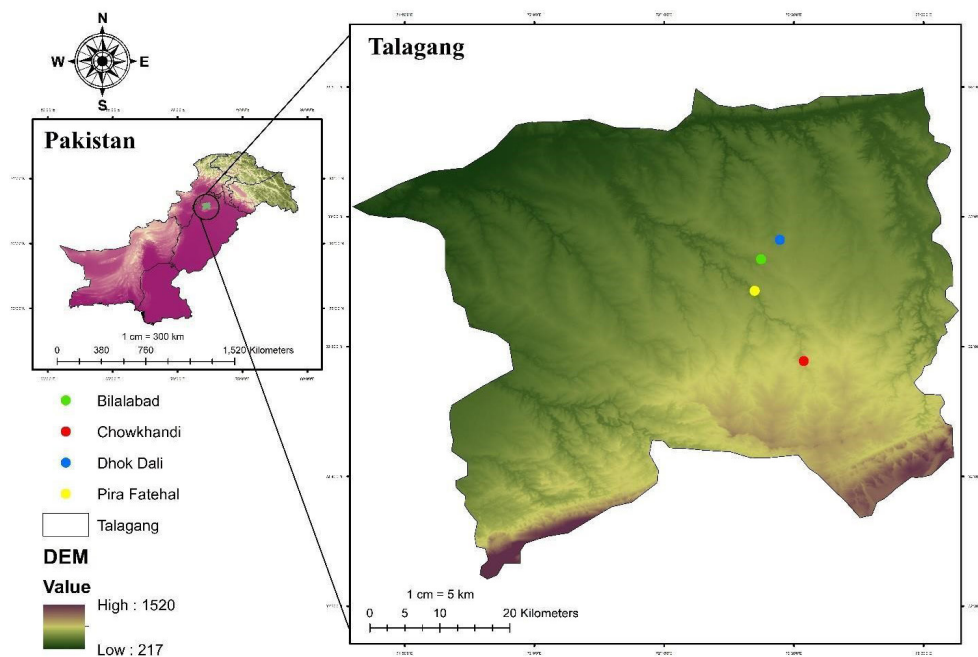
# Seasonal Fluctuations in the Dietary Habits of Indian Crested Porcupine (*Hystrix indica* Kerr) in Pothwar Plateau, Pakistan

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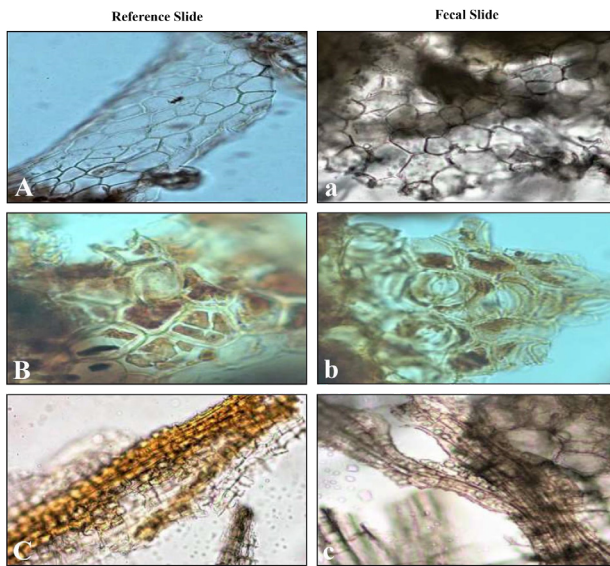
Supplementary Fig. 1. Map of the study area; showing the selected study sites for data collection.

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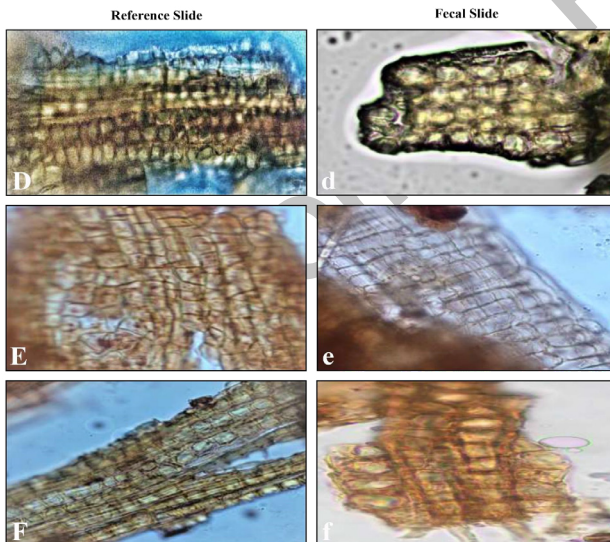


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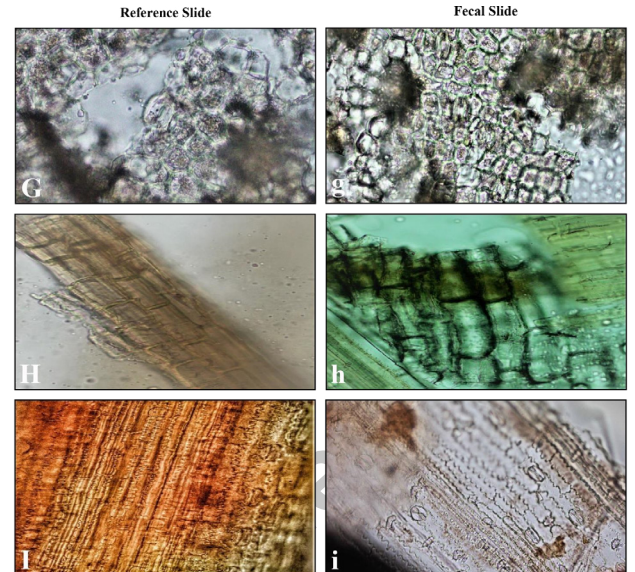
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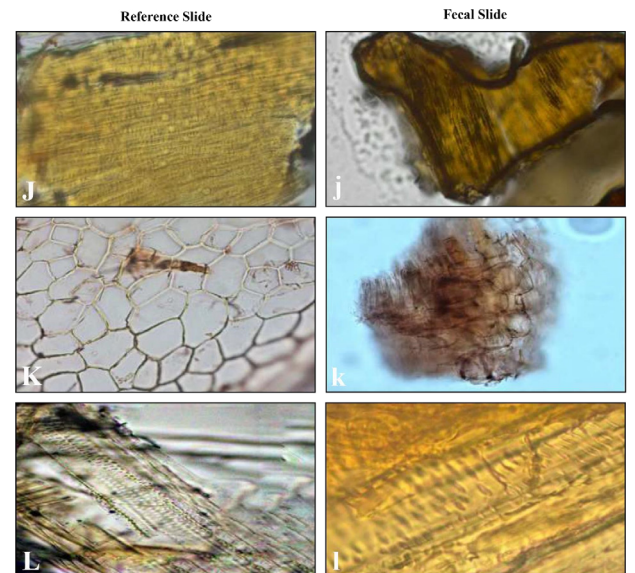
Supplementary Fig. 2. Light microscopic photographs of the fecal and reference sample slides of the vegetation samples prepared from the faeces of Indian crested porcupines in the Pothwar. A: Reference slide of bair/ jujube, a: Faecal slide of Bair/ Jube, B: Reference slide of leaves of Indian rosewood, b: Faecal slide of leaves of Indian rosewood, C: Reference slide of the stem of Indian rosewood, c: Faecal slide of the stem of Indian rosewood.



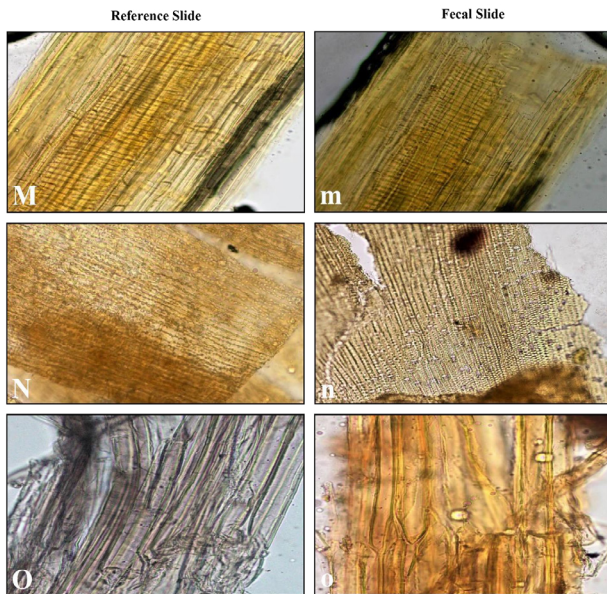
Supplementary Fig. 3. Light microscopic photographs of the fecal and reference sample slides of the vegetation samples prepared from the faeces of Indian crested porcupines in the Pothwar. D: Reference slide of kikar/ gum Arabic tree d: Faecal slide of kikar/gum Arabic tree, E: Reference slide of leaf of Phulahi, e: Faecal slide of leaf of Phulahi, F: Reference slide of the stem of Phulahi, f: Faecal slide of the stem of Phulahi.



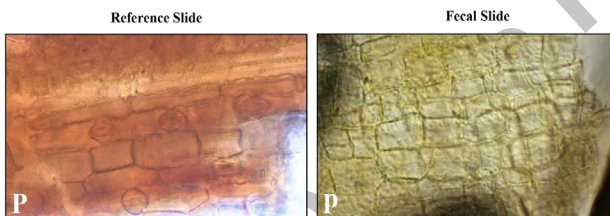
Supplementary Fig. 4. Light microscopic photographs of the fecal and reference sample slides of the vegetation samples prepared from the faeces of Indian crested porcupines in the Pothwar. G: Reference slide of Farash tree/ Khagal, g: Faecal slide of Farash Tree/ Khagal, H: Reference slide of Khabbal grass, h: Faecal slide of Khabbal grass, I: Reference slide of Dhab, i: Faecal slide of Dhab.



Supplementary Fig. 5. Light microscopic photographs of the fecal and reference sample slides of the vegetation samples prepared from the faeces of Indian crested porcupines in the Pothwar. J: Reference slide of Chickpea j: Faecal slide of Chickpea, K: Reference slide of Mustard, k: Faecal slide of Mustard, L: Reference slide of Wheat, l: Faecal slide of Wheat



Supplementary Fig. 6. Light microscopic photographs of the fecal and reference sample slides of the vegetation samples prepared from the faeces of Indian crested porcupine in the Pothwar, M: Reference slide of Maize m: Faecal slide of Maize, N: Reference slide of Pearl Millet, n: Faecal slide of Pearl Millet, O: Reference slide of Peanut / Groundnut, o: Faecal slide of Peanut/ Groundnut



Supplementary Fig. 7. Light microscopic photographs of the fecal and reference sample slides of the vegetation samples prepared from the faeces of Indian crested porcupine in the Pothwar, P: Reference slide of Potato; p: Faecal slide of Potato.