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FOOD HABITS OF THE INDIAN CRESTED PORCUPINE (*HYSTRIX INDICA)* IN FAISALABAD, PAKISTAN

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This study examines the food habits of the Indian crested porcupine (*Hystrix indica*) in Faisalabad, Punjab, Pakistan. Porcupine is an important vertebrate pest in Pakistan's agriculture, but there is little knowledge of food habits of this pest. During the present study, twenty *H. indica* were killed to examine their stomach contents and also collected sixty fecal pellets. Stomach contents and fecal pellets had correlation with feeding sites, plant material and the nature of food material consumed from both cultivated and non cultivated lands. The stomach contents and fecal pallets revealed that twenty seven species of plants were consumed by the porcupine as food items in Faisalabad. Diet of porcupine varied and comprised of vegetable matter. Tuber, roots, leaves, stems and spike of agricultural crops like *Triticum aestivum, Zea mays, Saccharum officinarum, Hordeum vulgare, Brassica oleracea, Brassica campestris, Allium cepa* were eaten extensively. It was observed that *H. indica* is the serious pest of agricultural crops and trees of the area.
Keywords: *Hystrix indica,* fecal pellets, stomach contents, food stuff, herbivore rodent

INTRODUCTION

The Indian crested porcupine (*Hystrix indica)* is a large herbivore rodent and is considered as a serious economic pest of crops and forest plantations (Ahmad and Chaudhry, 1977; Greaves and Khan, 1978; Roberts, 1997; Khan *et al.,* 2000, 2010). The porcupine inhabits canal-side plantations, embankments of drainage channels, irrigated forest-plantations and intensively cultivated croplands along canals and drains. They also often infest graveyards and mounds of scrapped soil in the corners of fields, in saline and sodic soil tracts (Arshad, 1987; Greaves and Khan, 1978).

Indian crested porcupine has been recorded as a serious pest of the traditional as well as non-traditional crops, including fruit orchards, vegetables, flowering plants, forages etc. (Alkon and Saltz, 1985; Khan *et al.*, 2000, 2007; Hussain, 2004; Pervez, 2006). Crops of economic importance, such as maize, groundnut and potato are severely damaged in irrigated plains and mountainous regions (Ahmad *et al.,* 1987; Brooks *et al*., 1988; Khan *et al.,* 1997, 2000). Among vegetables okra, pumpkin, carrot, bitter gourd and onion are badly damaged by this pest (Pervez, 2006). Porcupine damaged extensively grasses like *Cenchrus ciliaris, Sorghum helpenese, Cymbopogan jwarancusa* and *Elionurus hirsutus* at Karluwala (Bhakkar), a desert land of the southern Punjab, which is being seeded to enhance its grazing capacity on sustainable basis (Khan *et al*., 2000). Gutterman (1982) recorded more than 17 geophytes and hemicryptophytes being consumed by porcupines.

Porcupines are basically herbivores in feeding habits and prefer the bark of certain tree species, roots, bulbs and succulent tubers. Sometimes they prefer to consume ripened fruits. In Balochistan, they regularly excavate the bulbs of *Eremurs aurantiacus,* whereas in the Southwestern Punjab, they prefer the bark of Bakain (*Melia azedarach*). They also feed on mulberry (*Morus alba*) and mango (*Mangifera indica*) plants. Trees with thick and rough bark are mostly shunned (Roberts, 1997; Khan *et al*., 2000). Khan and Mian (2008) reported 30-70% damage to Gladiolus and Dutch Irish plantation in a floriculture farm, Islamabad. In spite of its status as a serious agriculture and forest pest, no study of its food and feeding habit in cropland of Faisalabad has been made so for. Hence the present study of porcupine diet based on fecal pellets and stomach contents analysis in Faisalabad, Punjab was carried out.

MATERIALS AND METHODS

Faisalabad stands in the rolling flat plains of northeast Punjab, between longitude 73°74 East, latitude 30°31.5 North, with an elevation of 184 m above sea level. There are no natural boundaries between Faisalabad and adjoining districts. In study area, 40 different plant species including diverse plants of xeric vegetation were recorded. Twenty four different plant species were identified from fecal pellet and stomach contents analysis. During one year period, monthly visits were made for fecal pellets and stomach collection from the fields and adjacent areas. The porcupines were trapped according to method of Shahid *et al.* (2007).

The experiment was conducted during January 2008 to June 2010. The entire study period was divided into four seasons: Spring (February-April); Summer (May-August); Fall (September-October) and Winter (November-January). Stomach contents (n=4) and fecal pellets (n=15) samples were taken during each season.

For reference slides, the vegetative parts of plants were dried and soaked in solution (distilled water, ethyl alcohol and glycerin (1:1:1 v/v) overnight and washed with tap water. After grinding in distilled water the contents were poured in micro sieve, 6 cm long hallow cylindrical having 0.05 mm pores and rubber stopper at one end. Then specimens were soaked in sodium hypochloride solution of 5% chlorox and 4 parts of distilled water for 20-30 minutes. Diluted acetic acid was added to neutralize its basic effects and placed in mordant solution for 15-30 minutes. The contents were placed in hematoxylin stain for 10-15 min. A drop of mounting medium (100 cc distilled water and 100 g Arabic gum) was added and spread on slide (22x40 mm). After overnight fastening, the slides were examined under the microscope.

Stomach contents obtained from porcupine were placed in 10% formalin and were put on a white paper having equal sized squares in a petridish where fragments of stomach contents were placed and examined microscopically (Ward, 1970).

The fecal pellets after washing over a mesh were put in70% alcohol for 10 minutes and stained with light green dye. Seven slides were prepared from each fecal pellet to examine under microscope (60×). Plant parts of each species placed in each box were calculated and the total number of the fragments recorded according to the method of Hansen *et al.* (1971).

The overall percent relative frequency was calculated as:

$$\text{rf (\%)} = \frac{\text{Total number of fragments of a species}}{\text{Total number of fragments analysed}} \times 100$$

The relative frequency of different food items recorded from the stomach content was compared with different seasons to work out the feeding preference of the species. The similar procedure was adopted for fecal pellet analysis.

RESULTS AND DISCUSSION

The analysis of spring samples of stomach contents revealed that 15 plant species were consumed by porcupines (Table 1). Among these, *T. aestivum* with mean relative frequency of 21.62±1.45% was the most intensively consumed in this season. *B. ceiba*, *B. campestris*, *Sorghum helpense* were in sufficient amount, while *Solanum melongena*, *Morus alba*, *Cynodon dactylon*, *Mangifera indica*, *Eucalyptus camaldulensis*, *Melia azedarach*, *Lathyrus aphaca*, *B. oleracea*, *Zizyphus mauritiana*, *Saccharum officinarum and Dalbergia sissoo* were utilized relatively less frequently. Unidentified fragments (2.47±0.41%) and other fragments (2.58±0.27%) of spring diet comprised of hair, spine and thread particles which were significant fraction of the total contents.

Figure 1 shows the percent consumption of different food parts like stem, leaf, seed, spike, tuber, flower and pod recovered from the stomach of porcupine collected during spring season. Leaf (26.3%), spike (22.3%), stem (19.3%), seed (17.7%) and root (11.2%) were consumed with a high frequency while flower (2.00%) and tuber (1.1%) were less frequently consumed.

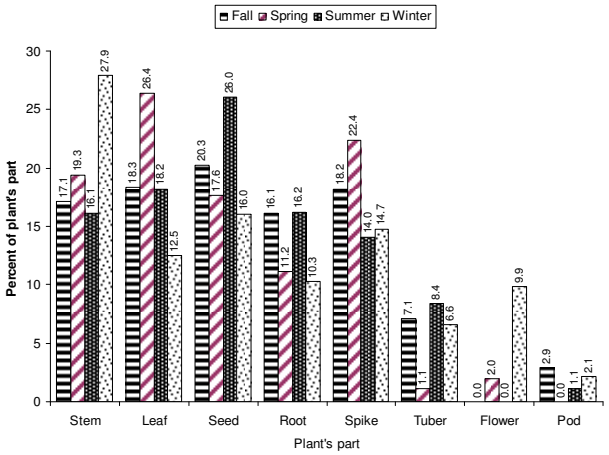

Figure 1. Percentage of parts of plants recovered from the stomach contents of *Hystrix indica* captured from Faisalabad

The analysis of the fecal pellets (Table 2) revealed that *T. aestivum* was consumed at the highest mean relative frequency, while *Hordeum vulgare*, *S. halepense*, *L. aphaca*, *M. azedarach*, *M. alba*, *Bombax ceiba*, *B. campestris* constituted sufficient portion of the diet. *B. oleracea*, *D. sissoo*, *E. camaldulensis*, *M. indica*, *Pisum sativum*, *Melilotus indica*, *Z. mauritiana* and *A. cepa* were recorded with different frequency. Other matter, unidentified parts of plants and unknown parts of plants were also included in its constituents. This confirmed the reports of Arshad *et al.* (1990) who provided some information about the diet of *H. indica* found in the 30 km radius around Faisalabad. Figure 2 showed the percent consumption of different parts of the plant species. Spike (32.9%), stem (22.3%), seed (17.2%) and leaf (13.7%) appeared with high frequency consumption. It confirms the findings of Inayatullah (2006).

Analysis of stomach contents collected during summer season revealed that 19 types of food items of plant origin were consumed by the porcupine (Table 1). Among these, *Z. mays* and *S. vulgaris* were predominant, as these constituted larger amounts of total stomach contents followed by *Prosopis juliflora*, *M. alba*, *M. azedarach*, *L. esulentum*. Among other items, *C. maxima*, *C. dactylon*, *B. ceiba*,

Table 1. Percent Relative frequency of different food items recovered from the stomach contents of *Hystrix indica* captured from Faisalabad.

Food items	Spring	Summer	Fall	Winter
Allium cepa	0.00 ± 0.00	2.06 ± 0.00	0.00 ± 0.00	2.91 ± 0.00
Bombix ceiba	12.58 ± 1.31	6.19 ± 0.00	9.16 ± 1.46	9.71 ± 0.30
Brassica campestris	9.19 ± 0.60	0.00 ± 0.00	0.00 ± 0.00	11.58 ± 0.09
Brassica oleracea	4.26 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	5.20 ± 2.17
Cucumis melo	0.00 ± 0.00	5.36 ± 0.28	3.76 ± 1.51	0.00 ± 0.00
Cucurbita maxima	0.00 ± 0.00	6.70 ± 3.61	0.00 ± 0.00	0.00 ± 0.00
Cynodon dactylon	6.71 ± 0.69	6.36 ± 1.10	8.59 ± 0.71	5.89 ± 0.24
Cyperus rotundus	0.00 ± 0.00	4.08 ± 0.42	6.91 ± 0.51	2.56 ± 0.69
Dalbergia sissoo	3.03 ± 0.00	2.72 ± 0.37	9.60 ± 0.51	2.60 ± 0.00
E. camaldulensis	5.54 ± 0.36	3.78 ± 0.34	4.04 ± 0.72	2.91 ± 0.00
Hordeum vulgare	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	10.81 ± 1.47
L.esculentum	0.00 ± 0.00	7.81 ± 0.74	0.00 ± 0.00	0.00 ± 0.00
Lathirus aphaca	4.67 ± 0.67	4.95 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Mangifera indica	6.01 ± 0.62	3.05 ± 0.04	3.70 ± 1.07	7.69 ± 2.69
Melia azedarach	4.74 ± 1.46	7.92 ± 0.80	11.87 ± 0.63	8.47 ± 1.49
Melilotus indica	0.00 ± 0.00	3.06 ± 0.03	0.00 ± 0.00	0.00 ± 0.00
Morus alba	7.31 ± 1.04	8.91 ± 0.00	0.00 ± 0.00	7.28 ± 0.30
Prosopis juliflora	0.00 ± 0.00	13.40 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Psidium guajava	0.00 ± 0.00	2.54 ± 0.56	0.00 ± 0.00	7.00 ± 0.50
Saccharum officinarum	3.69 ± 1.36	0.00 ± 0.00	4.27 ± 0.38	4.41 ± 1.91
Solanum melongena	7.52 ± 0.62	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Sorghum halepense	9.01 ± 1.48	3.09 ± 0.00	10.11 ± 0.00	12.79 ± 0.00
Sorghum vulgaris	0.00 ± 0.00	17.35 ± 0.86	19.51 ± 3.47	0.00 ± 0.00
Triticum aestivum	21.62 ± 1.45	0.00 ± 0.00	0.00 ± 0.00	18.38 ± 3.47
Zea mays	0.00 ± 0.00	17.38 ± 1.25	18.69 ± 2.53	0.00 ± 0.00
Ziziphus mauritiana	4.04 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	6.19 ± 1.34
*Other	2.58 ± 0.27	2.56 ± 0.31	2.64 ± 0.20	2.52 ± 1.23
**Unidentified	2.47 ± 0.41	3.68 ± 1.62	4.04 ± 0.82	6.79 ± 0.86
Unknown plant	5.65 ± 0.63	5.87 ± 0.49	5.92 ± 0.91	4.36 ± 0.71

*Other = Quill, Hair and Thread. **Unidentified = Unidentified material. Values are (Means±SE).

Cucumis melo, *L. aphaca*, *C. rotundus*, *E. camaldulensis*, *S. halepense*, *M. indica*, *M. indica*, *D. sissoo* , *P. guajava* and *A. cepa* were consumed occasionally. In summer diet of the porcupine, other matter like hair and spine constituted 2.56±0.31% whereas unidentified plant stuff and unknown matter constituted 3.68±1.62% and 5.87±0.49% respectively. During this season, maize is widely cultivated and severely damaged by porcupines (Ahmed *et al.*, 1987).

Analysis of plant parts during the summer season showed (Fig. 1) that seeds (26.3%) were consumed with high frequency followed by leaf (18.1%), stem (16.1%), spike (14.0%), tuber (8.4%) and pods (1.1%). Maximum consumption of seeds and leaves during summer also confirms the reports of Inaytullah (2006).

The analysis of the fecal pellets in summer season showed that 17 types of food items of plant origin were consumed at different frequency by porcupines (Table 2). *Z. mays* and *S. vulgaris* were the most intensively consumed species during this season. *B. campestris*, *C. dactylon*, *M. azedarach* and *Msorus alba* appeared in high frequency. *M. indica*, *S. halepense*, *E. camaldulensis*, *B. ceiba*, *D. sissoo*, *C. rotundus*, *C. melo*, *S. nigrum*, *S. tuberosum*, *S. officinarum* and *Z. mauritiana* were less frequently recovered. Other matters were found less frequently while unidentified material 8.75±1.04% and unknown plant parts were 8.68±0.45%. The analysis of plant parts showed (Fig. 2) that stem (24.5%) showed the highest consumption followed by seed (21.4%), spike (16.3%), tuber (10.1%) and pod (5.6%).

Plant tissues belonging to 12 species were recovered from stomach of porcupine dung Fall season, (Table 1). *S. vulgaris* was the most intensively consumed species. *Z. mays*, *M. azedarach*, *S. halepense*, *D. sissoo*, *B. ceiba*, *C. dactylon*, *C. rotundus*, *S. officinarum*, *E. camaldulensis*, *C. melo* and *M. indica* were consumed in significant proportions, while unknown plant parts also constituted a significant part of stomach contents (5.92±0.91%) and unidentified plant or unknown matter was 4.04±0.82%. During fall season, roots, stems, leaves, seeds, tuber and spike were consumed in varying frequency. Seeds were consumed with high frequency (20.2%) following by leaf

Table 2. Percent Relative frequency of different food items recovered from the fecal pellets of *Hystrix indica* captured from Faisalabad

Food items	Spring	Summer	Fall	Winter
Allium cepa	5.19± 0.58	0.00± 0.00	0.00± 0.00	4.70± 1.09
Bombix ceiba	10.90± 2.74	8.24± 0.89	11.61± 0.88	15.71± 0.96
Brassica campestris	10.68± 1.08	11.50± 2.55	13.32± 3.76	0.00± 0.00
Brassica oleracea	9.88± 1.93	0.00± 0.00	0.00± 0.00	7.63± 1.28
Cucumis melo	0.00± 0.00	5.16± 0.57	4.55± 0.00	0.00± 0.00
Cynodon dactylon	0.00± 0.00	11.03± 1.05	9.27± 1.20	15.01± 1.15
Cyperus rotundus	0.00± 0.00	5.57± 0.84	8.53± 1.00	2.51± 1.12
Dalbergia sissoo	9.80± 1.41	7.77± 0.90	8.54± 1.56	7.08± 1.07
E. camaldulensis	9.74± 1.83	8.78± 1.19	10.28± 1.36	8.48± 0.73
Hordeum vulgare	19.00± 5.45	0.00± 0.00	0.00± 0.00	20.75± 4.83
Lathirus aphaca	11.67± 0.00	0.00± 0.00	0.00± 0.00	0.00± 0.00
Mangifera indica	9.22± 2.40	9.98± 1.94	6.55± 0.75	6.61± 0.35
Melia azedarach	11.58± 0.83	11.01± 1.52	12.85± 1.27	8.48± 0.65
Melilotus indica	8.44± 1.67	0.00± 0.00	0.00± 0.00	0.00± 0.00
Morus alba	11.08± 2.23	10.55± 1.15	10.73± 1.37	7.37± 1.25
Pisum sativum	8.58± 3.92	0.00± 0.00	3.92± 0.00	0.00± 0.00
Psidium guajava	0.00± 0.00	0.00± 0.00	4.69± 0.00	7.15± 1.25
Saccharum officimale	0.00± 0.00	3.58± 0.30	4.69± 0.44	4.21± 1.02
Solanum nigrum	0.00± 0.00	4.83± 0.65	8.97± 1.81	0.00± 0.00
Solanum tuberosum	0.00± 0.00	4.76± 0.00	5.88± 0.00	0.00± 0.00
Sorghum halepense	14.15± 1.21	9.94± 2.26	9.39± 1.40	10.57± 1.17
Sorghum vulgaris	0.00± 0.00	21.42± 1.74	17.09± 3.16	6.12± 0.64
Triticum aestivum	29.37± 1.33	0.00± 0.00	0.00± 0.00	23.23± 2.23
Zea mays	0.00± 0.00	24.05± 1.65	25.60± 1.81	0.00± 0.00
Ziziphus mauritiana	5.21± 1.02	1.59± 0.20	6.37± 1.26	1.60± 0.21
*Other	1.52± 0.00	3.29± 1.36	2.95± 0.64	4.17± 0.00
**Unidentified	7.51± 0.53	8.75± 1.04	4.01± 0.48	7.24± 0.55
Unknown plant	10.00± 0.65	8.68± 0.45	9.27± 0.81	8.60± 0.65

*Other = Quill, Hair and Thread. **Unidentified = Unidentified material. Values are (Means±SE).

(18.3%), spike (18.1%), stem (17.1%), root (16.1%), tuber (7.1%) and pod (2.8%).

The fecal samples of porcupine which were collected during fall season showed high mean relative frequency of *Z. mays* (25.60±1.81%) which remained the most intensively eaten food. *S. vulgaris*, *B. campestris*, *M. azedarach*, *B. ceiba*, *M. alba*, *E. camaldulensis* were significantly consumed by porcupine. *S. halepense*, *C. dactylon*, *S. nigrum*, *D. sissoo*, *C. rotundus*, *M. indica*, *Z. mauritiana*, *S. tuberosum*, *S. officinarum*, *S. nigrum*, *C. melo* and *P. sativum* were taken in decreasing frequency. Other matters constituted 2.95±0.64% but were eaten less intensively. In fecal pellets, seeds (22.6%) were recovered in significantly high proportion followed by stem (18.4%), spike (16.3%), leaf (13.1%), tuber (8.3%), pod (3.2%) and flower (1.6%) of the different plant species (Fig. 2).

The specimens of stomach contents analyzed during winter season revealed that 17 plant species were consumed by porcupine (Table 1). Among these, *T. aestivum was* predominantly consumed plant species while *S. halepense*, *B. campestris*, *H. vulgare*, *B. ceiba*, *M. indica, M. azedarach*, *M. alba*, *Psidium guajava* and *Z.mauritiana* were present in sufficient amount. Unidentified food items (6.79±0.86%) and unknown plant parts (4.36±0.71%) other matters including hair, spine and thread particles contributed (2.52±1.23%) of the total contents. Stem (27.9%), seed (16.0%), spike (14.7%), leaf (12.5%) and root (10.2%) were recovered with high frequency. Flower (9.8%), tuber (6.5%) and pod (2.1%) were less frequent (Fig. 1). It confirms the finding of Sarwar (1990).

Seventeen type of food items of plant origin were recovered from fecal sample collected in winter (Table 2). *T. aestivum* was present in sufficient amount, while *H. vulgare*, *B. ceiba*, *C. dactylon* and *S. halepense* were also recovered sufficiently. *E. camaldulensis*, *M. azedarach*, *B. oleracea*, *M. alba*, *P. guajava*, *M. indica*, *S. vulgaris*, *A. cepa*, *S. officinarum*, *C. rotundus* and *Z. mauritiana* were found less frequently. Other matter, unknown plant parts were found in significant percentage. The analysis of fecal pellets suggested that stem (29.7%). Spike (17.9%), seed (16.0%)

and root (10.3%) contributed a significant part of total fecal contents. It confirms the finding of Roberts (1997), Arshad *et al*. (1990) and Brooks *et al*. (1988).

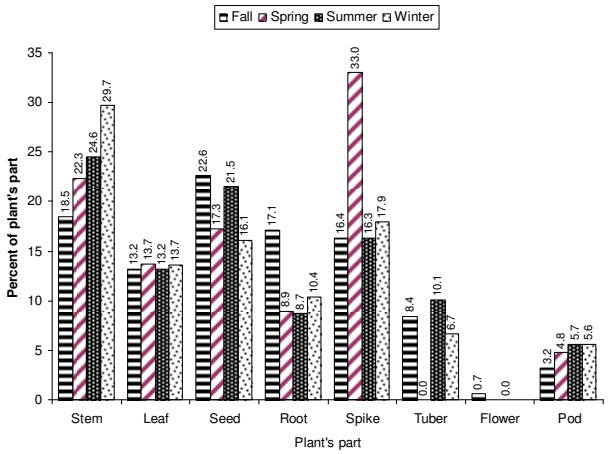

Figure 2. Percentage of parts of plants recovered from the fecal pellets of *Hystrix indica* collected from Faisalabad

A total of 27 plant species could be identified. The overall pictures of the sample analysis showed the maximum consumption of stem in winter and maximum spike in spring season as part of fecal pellets and stomach contents. Pods were consumed round the year. This confirms the observation of Greaves and Khan (1978). Chi-square test of stomach contents across the seasons showed that the results of crops and non-crops were non-significantly (X^2 = 0.989*NS*, P= 0.804) different. Similarly regarding fecal pellets Chi square test across the seasons revealed that crops and non-crops results were non-significant (X^2 = 2.205*NS*, P= 0.531). The study also confirmed the finding of Pervez *et al.* (2005) where stems were noted to be the preferred food items. Arshad *et al.* 1990 analysis of gut contents showed the presence of leaves, fruit, bark, roots of different crops, vegetable, grasses and trees. Inayatullah (2006) conducted study in Tarbela watershed areas and reported that porcupine depends upon minimum of 29 cultivated and wild plant species, and the preferable species included *M. azedarach, P. roxburghii, Z. mays, S. helepense* and *T. aestivum.*

CONCLUSION AND RECOMMENDATIONS

It is obvious from this study that *H. indica* is largely herbivorous in diet and serious pest of seasonal vegetable, fruit, trees, crops and grasses. For proper management, burrow fumigation through aluminum phosphide (3g) tablets followed by second generation anticoagulant bait is recommended. A sustained pest vigilance coupled with constant monitoring is suggested to check for any recurrence of the pests after implementing control measures.

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