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Original Article

Dietary habits of lesser bandicoot rat (*Bandicota Bengalensis*) in an agro-ecosystem, Pothwar Plateau, Pakistan

Hábitos alimentares de rato bandicoot (*Bandicota Bengalensis*) em um agroecossistema do Planalto de Pothwar, Paquistão

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Abstract

Dietary habits of bandicoot rats (*bandicota bengalensis*) were investigated in the agricultural crops of the Pothwar Plateau, Pakistan by analysing stomach contents. The research activities were conducted in major field crops including wheat-groundnut and in the fallow lands during non-crop season at the field boundaries. The specimens were captured from the fields using kill/snap traps, and dissected to collect their stomach samples for laboratory analysis. Light microscopic slides of the plant material were recovered from stomach samples and the reference materials were collected from the field. Results revealed that the bandicoot rat predominantly fed upon cultivated crops during cropping season but consumed wild vegetation during non-cropping season. There was no significance difference between summer and winter diets. Most frequently consumed crop food items were wheat (*Triticum aestivum*; 28.57%), groundnut (*Arachis hypogea;* 11.26%), sorghum (*Sorghum bicolor;* 10.17%), chickpea (*Cicer arietinum*; 9.52%), maize *(Zea mays*; 6.49%), millet (*Pennisetum glaucum*; 5.84%), barley *(Hordeum vulgare;* 4.98%) and mustard *(Brassica campestris;* 4.98%). Among wild vegetation were consumed khbal gha (*Cynodon dactylon;* 7.79%), baron dhab (*Demostachya bipinnata;* 7.36%) and Prickly flower (*Achyranthes aspera*; 3.03%). The study concludes that, in addition to consuming wheat and groundnut crops, the Lesser bandicoot rat also subsists on grasses, weeds, and some fodder crops, as important component of its diet in agro-ecosystem of the Pothwar Plateau.

Keywords: bandicoot rat, diet, trapping, Pothwar, wheat, groundnut, stomach.

Resumo

Os hábitos alimentares de ratos bandicoot (*Bandicota bengalensis*) foram investigados nas plantações agrícolas do planalto de Pothwar, Paquistão, por meio da análise do conteúdo estomacal. As atividades da pesquisa foram conduzidas nas principais culturas de campo, incluindo trigo e amendoim, e em terras de pousio durante a estação não agrícola nos limites do campo. Os espécimes foram capturados dos campos usando armadilhas kill/snap e dissecados para coletar suas amostras de estômago para análise laboratorial. Lâminas de microscopia de luz do material vegetal foram recuperadas de amostras de estômago; os materiais de referência foram coletados no campo. Os resultados revelaram que o rato bandicoot alimentava-se predominantemente de culturas cultivadas durante a época de cultivo, mas consumia vegetação selvagem durante a época de não colheita. Não houve diferença significativa entre as dietas de verão e inverno. Os alimentos agrícolas mais frequentemente consumidos foram trigo (*Triticum aestivum*; 28,57%), amendoim (*Arachis hypogea*; 11,26%), sorgo (*Sorghum bicolor*; 10,17%), grão de bico (*Cicer arietinum*; 9,52%), milho (*Zea mays*; 6,49%), milheto (*Pennisetum glaucum*; 5,84%), cevada (*Hordeum vulgare*; 4,98%) e mostarda (*Brassica campestris*; 4,98%). Entre a vegetação silvestre foram consumidos khbal gha (*Cynodon dactylon*; 7,79%), barão dhab (*Demostachya bipinnata*; 7,36%) e flor espinhosa (*Achyranthes aspera*; 3,03%). O estudo conclui que, além de consumir culturas de trigo e amendoim, o rato bandicoot pequeno também subsiste de gramíneas, ervas daninhas e algumas culturas forrageiras, componentes importantes de sua dieta no agroecossistema do planalto de Pothwar.

Palavras-chave: rato bandicoot, dieta, armadilhagem, Pothwar, trigo, amendoim, estômago.

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1. Introduction

Among all mammalian groups, rodents are the largest one, comprising of nearly 2700 species belonging to 30 families (Aplin et al. 2003). The remarkable adaptability and opportunism that exemplify rodent feeding behaviors are evident in their diverse and versatile feeding apparatus. All rodents are characterized by a single pair each of chisel-like upper and lower incisors, which are both self-sharpening and ever-growing. Rodents are a natural constituent of agricultural ecosystems where they play a significant role, particularly in food chains. Their characteristic is a high rate of reproduction and associated fluctuation in their richness within seasons of the year and over periods of several years. They particularly thrive in agricultural areas well-interspersed with woodlots and riparian habitat, favoring early successional stages, which keep brush and sapling browse within reach (Craven and Hygnstrom, 1994). Furthermore, rodents also presumably benefit more from edges adjacent to agricultural fields, streams, and grasslands during non-crop period where they can have access to shrubs and forbs, which comprise some of their main forage sources (Retamosa et al., 2008).

Rodents are the ultimate Mammalia living in almost every habitat on earth, some of the ecological roles include soil mixing and aeration, seed and spore dispersal, influences on plant species composition and abundance, and serving as a prey base for many predatory vertebrates and therefore the non-pest species need to be protected (Witmer and Singleton, 2010). But generally, they are recognized as a pest species in different situations in urban and rural habitats (Dolbeer, 1999; Fall and Jackson, 1998). Despite their beneficial role in an ecosystem, they are a serious impediment to agricultural cropping systems and can cause serious economic losses, both in rural and urban settings (Buckle et al., 1985). Stenseth et al., 2003). Economic losses are reported in millions of US dollars (Dolbeer, 1999). Rodents harm human interests by causing direct losses to stored food and field crops. Rodents are considered to be the main vertebrate pests and damage many crops in the Pothwar Plateau (Hussain et al., 2003). On average, they cause losses of 4-10% in field crops (mainly wheat and groundnuts) at their different growth stages (Brooks et al., 1988; Fulk et al., 1980a; Khan et al., 2009). As far as public health is concerned; rodents act as vectors in the transmission of various disease organisms or parasites including *Salmonella* spp., *Campylobacter* spp., *Leptospira interrogans* and *Toxoplasma gondi* (Meerburg and Kijlstra, 2007, Meerburg et al., 2009, Mushtaq-Ul-Hassan et al., 2008).

The lesser bandicoot rat (*Bandicota bengalensis)* is one of the most abundant rodent pests in crop fields of Pakistan. It is also a serious problem of wheat throughout southern and south-eastern Asia (Munawar et al., 2019). Pakistan has two isolated populations of this rat, one throughout central and northern Punjab and in the southern part of Khyber Pakhtunkhwa province, and the other in the southern Sindh (Smiet et al., 1978; Roberts, 1997). It is a medium sized dark brownish grey in colour, coarse-furred rat with nearly bare tail, slightly shorter than the head and tail. This burrowing rat also hoards a large quantity of food in its burrows (Munawar et al., 2019). Among small mammals, the most thoroughly studied hoarder is the lesser bandicoot rat (Fulk, 1977; Maqbool et al., 2011). The reproductive cycle of *B. bengalensis* corresponds with the harvesting stage of the crop and moderate temperature and photoperiod. Pakistan faces a tremendous loss to the crops at maturity and harvesting stages due to damage caused by bandicoot rats. These losses have been assessed as 2-7% for wheat (Beg et al., 1978; Ahmad et al., 1986; Fulk et al., 1980b), and 3-5% in groundnut (Brooks et al., 1988, Roberts, 1981).

The Pothwar Plateau is considered an agricultural system of low rainfall dry land (Oweis and Ashraf, 2012, Rashid and Rasul, 2011) and low soil organic substance (Latif et al., 2008, Mahmood et al., 2010, Rashid et al., 2008). Due to low quality soil, deficiency of water and small farm size, agricultural productivity in this region is low. However, so far no particular scientific studies have been focussed on dietary habits of this species in this particular Plateau. Therefore, the focal aim of the current study was to investigate the dietary habits of bandicoot rat by stomach contents analysis and to study the variation in its food composition during cropping and non-cropping seasons and to determine the most common food resources exploited by this rodent species from the wheat-groundnut over a 11-month period.

2. Materials and Methods

2.1. Study area

The current study was carried out in the Pothwar Plateau, situated in the north of Punjab province between 32º 33 and 34º 3 N, and 71º 89 and 73º 37 E, upland at 305-610 m above sea level. The duration of the study was from July 2018 to June 2019 in agriculture areas of selected study sites (Attock, Chakwal, Jhelum and Rawalpindi) of the Pothwar Plateau (Table 1). While selecting a particular sites, due considerations were given to; bandicoot rat population, level of infestation and cooperation of the native farmers. The research activities were conducted in two major field crops; wheat and groundnut at various growth stages and in the fallow lands during non-crop seasons at the field boundaries of these respective crops.

2.2. Trapping methodology

During the current study, the lesser bandicoot rat specimens were trapped from the fields by using snap/kill traps, on a fortnightly basis. The kill traps were equipped with small pieces of different food baits, that is, guava, tomato and chapatti with pickles and peanut butter to avoid bait shyness. The traps were placed near the burrows of the bandicoot rat into the prevailing crop field's wheat, groundnut, and beneath the wild flora (vegetation) on the field borders. Variable numbers of kill traps were used to capture bandicoot rat specimens at selected sites. Traps were placed in the field at dusk and removed next dawn between 5 to 9 am. The trapped rat specimens were labelled with the specimen number, sex, capture location and date of capturing.

Table 1. Details of the four selected sampling sites in the Pothwar Plateau for data collection.

Site No	Name of site	Habitat Type	No of specimens trapped	Latitude	Longitude	Elevation (m)
1	Jatli	Cropland Non-cropland	6	N33°11.067',	E073°05.579'	542m
2	Khairi Maurt	Cropland Non-cropland	3	N33°29.626',	E072°48.061'	564m
3	Ahmed Abad Qabristan	Cropland Non-cropland	6	N32°31.400',	E072°51.768'	193m
4	Khair pur	Cropland Non-cropland	5	N32°44.041',	E072°48.664'	474m

2.3. Investigation of dietary habits

The diet composition of the bandicoot rats was studied following the method used by Sparks and Malechek (1968). The captured specimens were dissected in the laboratory to remove their stomachs by removing oesophagus approximately 1.5 cm below the duodenum and 1.5 cm above the stomach to collect the stomach samples for analysis. The study comprised of two parts, that is, preparation of stomach content slides and preparation of reference slides of different plants found at the selected sampling sites. The standard morphological measurements were taken for each rat collected by following Aplin et al. (2003).

2.4. Micro-histology of stomach contents

During micro-histology, the stomach samples were weighed and then opened carefully, and the materials were emptied into a petri dish and were weighed. Then the recovered materials were oven dried and then sieved using 1 mm mesh size sieve. The remaining residue was ground by using a pestle and mortar to reduce its size. The residues were then washed in a test tube by soaking the solution (1 part H_2O+1 part ethyl alcohol+1 part glycerin) to remove further dirt particles and were soaked in solution for overnight. Next morning, the mixtures were homogenized by using Vitric homogenizer (ESB-500 Lab homogenizer) for 5 to 10 minutes for each sample to further reduce its size. Sodium hydroxide solution (NaOH) at a concentration of 5% was added into test tubes containing samples and heated for 4 to 6 minutes, left for particle settling and then removed the floating dark skin on the test tubes. Samples were again washed in warm water and then evaporated by using alcohol grades (25%, 50%, 75%, and 100%) for 10 min at each concentration. Solutions of xylene and alcohol at different concentrations (25%, 50%, 75%, and 100%) were also added to the test tubes to remove alcohol. Finally, the concentrated samples were allowed to dry for an overnight. The following morning, the light microscopic slides were prepared and mounted using DPX and covered by placing cover slips on the glass slides.

The prepared light microscopic slides were studied under light microscope (IM-900) and all the necessary details of different plant cells from the slides were recorded and identified by comparing with those of reference slides. The slides were photographed for comparison with reference slides. Frequency of occurrence of different food particles in the stomach samples were calculated by using following Formula 1:

$$Frequency\ of\ occurrence\ = \frac{No\ of\ samples\ with\ specific\ food\ contents}{total\ number\ of\ samples} \times 100 \quad (1)$$

2.5. Statistical analysis

The data were statistically analysed using one way Analysis of Variance (ANOVA) for seasonal differences in dietary composition of the rodent species.

3. Results

3.1. Trapping success

Trapping data revealed that the success of capturing was higher when guava was used as bait in kill traps. A total of 20 specimens were trapped during the study period, whereby the trapping success was higher in cropping season of wheat (n = 12), followed by groundnut (n = 08) crops. During non-cropping season, the success was low and most of the capturing was done from the field boundaries of the wheat and two specimens were captured from the field boundaries of the groundnut fields. The results of trapping success during cropping and non-cropping season (summer and monsoon) showed the statistically significant difference ($P < 0.05$).

3.2. Diet composition

The stomach samples of the captured specimens, analysed in the laboratory showed that the lesser bandicoot rat predominantly consumed cultivated crops during cropping season. Its diet was primarily comprised of cultivated crops seeds, whereas weeds were present in some of the stomach samples that were captured during non-cropping season. Results revealed that the lesser bandicoot rat consumed eight different seasonal crops as well as wild vegetation. Among crops, the most frequently consumed (in terms of frequency of occurrence

%F) was wheat (*Triticum aestivum*; 28.57%), followed by groundnut (*Arachis hypogea;* 11.26%) any others (Table 2; Figure 1). More rats were captured in wheat, implying that wheat crop provided good shelter and energy rich food to the *B. bengalensis* at the maturity. This crop stage also corresponds to the breeding activity of this rodent in Pothwar agro-ecosystem (Munawar et al., 2018). Among wild vegetation, the rodent species fed upon Khbal gha (*Cynodon dactylon),* Baron dhab (*Demostachya bipinnata),* and Prickly flower (*Achyranthes aspera*) (Table 2; Figure 1).

In terms of percent volume consumption (%V), wheat was also consumed most heavily (49.25%), followed by groundnut (11.78%) with least contribution from barley (2.88%). Among wild vegetation, Baron dhab was heavily consumed, followed by Khabal gha and least consumed was prickly flower (Table 2; Figure 1).

3.3. Seasonal variation in diet composition

3.3.1. Autumn food

Analysis of stomach samples of lesser bandicoot rat collected during autumn season (October – November 2018) from the study area showed that groundnut was the most frequently and most heavily consumed during the autumn season, followed by sorghum, while least consumed was maize (Table 3; Figure 2). Among wild vegetation Khabal gha (*Cynodon dactylon*) was most frequently and most heavily consumed, followed by dhab (*Demostachya bipinnata*), and least consumed was prickley flower (*Achyranthes aspera*) (Table 3; Figure 2).

3.3.2. Winter food

During winter season, among crops, consumption of wheat was dominant, followed by chickpea while millet (*Panicum miliaceum*) was least consumed (Table 3; Figure 2). Among wild vegetation, dhab (*Demostachya bipinnata*) was most frequently consumed.

3.3.3. Spring food

During spring season, consumption of wheat dominated over all crops while no groundnut was available to the rodent species during this season (Table 3). Among weeds, most frequently and heavily consumed during spring was *Cynodon dactylon* (khabal gha) (Table 3; Figure 2).

3.3.4. Summer food

During summer season, groundnut was most frequently and most heavily consumed crop by lesser bandicoot rat, followed by Sorghum (Table 3; Figure 2) whereas among weeds, *Cynodon dactylon* was dominant.

3.4. Comparison between cropping and non-cropping seasons

In the Pothwar Plateau, winter and spring are the cropping seasons for wheat while summer and autumn are the cropping seasons for groundnut. During cropping season, wheat showed highest frequency of consumption during spring (21.25 ± 1.25%), followed by winter (11.75 ± 1.11%). During summer and autumn, no evidence of wheat consumption was available in the stomach samples of the lesser bandicoot rat. Groundnut was more frequently consumed during summer (14.75 ± 0.25) season, followed by autumn (14.25 ± 0.48) and winter (3 ± 0.41), respectively, while during spring no consumption of groundnut was detected in the stomach samples of the bandicoot rat. The mustard was most frequently consumed by bandicoot rat in winter (4.75 ± 1.70), followed by spring (Table 3). The consumption of Sorghum (10.25 ± 0.95) was high during autumn, followed by summer (10 ± 1.25), but less frequently consumed during winter (2.25 ± 1.31), and spring (2.25 ± 0.25). Millet crop was frequently consumed

Table 2. Percentage frequency (%F) and percentage volume (%V) occurrence of food items in stomach samples of lesser bandicoot rat (*Bandicoota bengalensis)* captured from Pothwar Plateau.

Food Items consumed by ***Bandicota bengalensis***			% F	% V
	Agricultural Crops	**Scientific name**		
1	Wheat	*Triticum aestivum*	28.57	49.25
2	Groundnut	*Arachis hypogea*	11.26	11.78
3	Mustard	*Brassica campestris*	4.98	3.26
4	Sorghum	*Sorghum bicolor*	10.17	6.64
5	Millet	*Panicum miliaceum*	5.84	3.76
6	Maize	*Zea mays*	6.49	3.76
7	Chickpea	*Cicer arietinum*	9.52	6.39
8	Barley	*Hordeum vulgare*	4.98	2.88
	Wild vegetation/ weeds			
1	Khabal gha	*Cynodon dactylon*	7.79	5.14
2	Dhab	*Desmostachya bipinnata*	7.36	5.26
3	Prickley flower	*Achyranthes aspera*	3.03	1.88

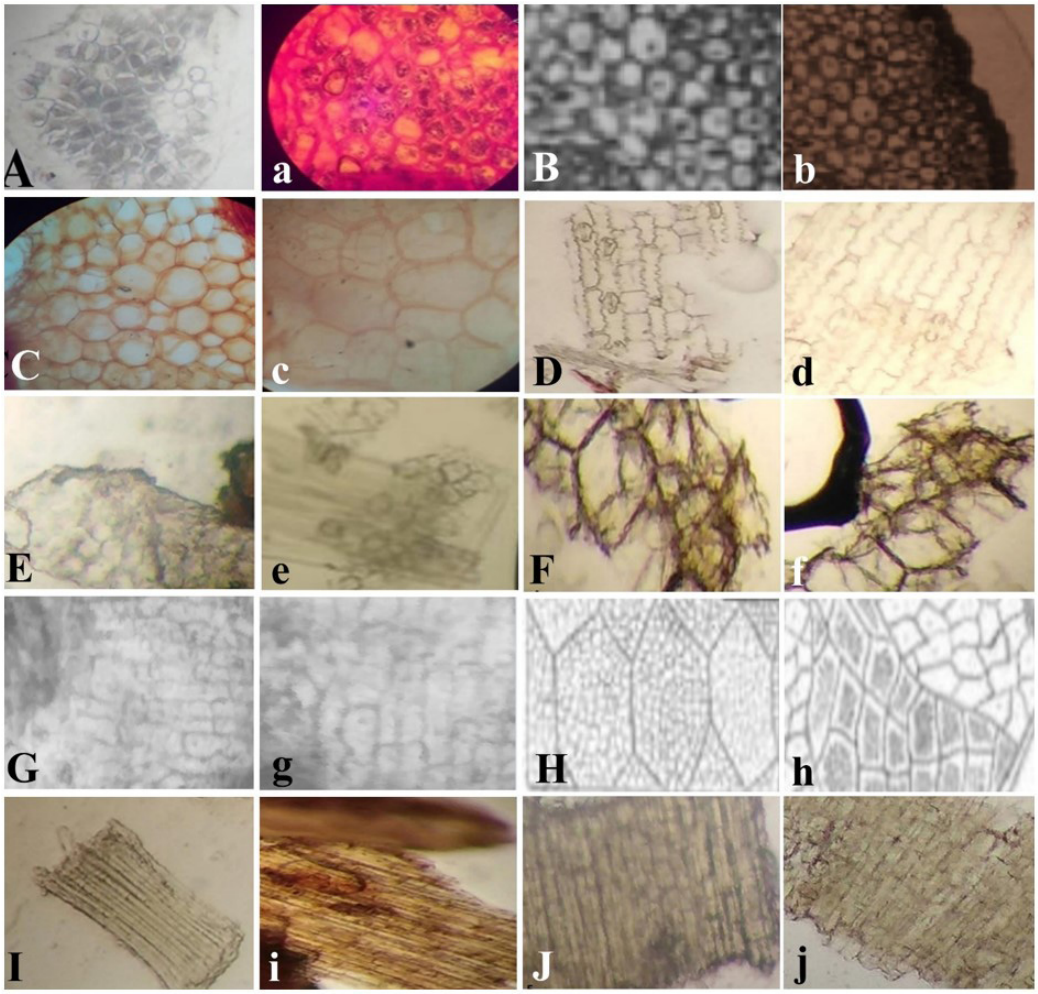

Figure 1. Light microscopic photographs of the plant materials recovered and identified from the stomach contents of the bandicoot rat in comparison with reference slides. Letters in capital show materials recovered from the stomach contents while letters in small represent reference slides. Plate Labels: A. Wheat, B. groundnut, C. mustard, D. sorghum, E. maize, F. chickpea, G. barley, H. millet, I. *Cyanodon*, J. *Desmostachya*.

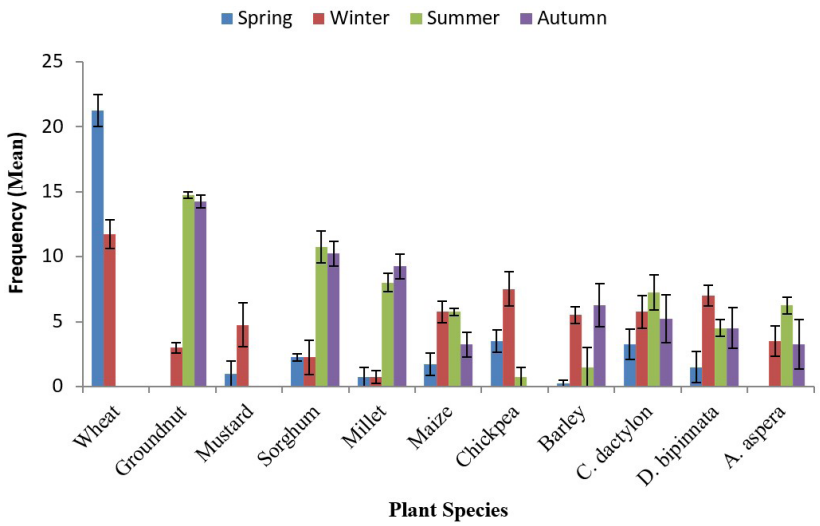

Figure 2. Seasonal variation in consumption of food items (%F) by *Bandicota bengalensis* during 2018-19 from Pothwar region.

Table 3. Percent frequencies (%F) and percent volume (%V) (mean± SE) occurrence of different food items recovered from stomach contents of lesser bandicoot rat (*B, bengalensis)* samples (n = 20) from Pothwar region during four different seasons of the study period (2018-19).

Food items	Autumn (n= 5)		Winter (n = 3)		Spring (n = 7)		Summer (n = 5)	
	%F	%V	%F	%V	%F	%V	%F	%V
Crops								
Wheat	-	-	**11.75 ± 1.11**	**15.5 ± 1.55**	21.25 ± 1.25	82.75 ± 1.93	-	-
Groundnut	14.25 ± 0.48	30 ± 1.68	3.00 ± 0.41	3.25 ± 0.63	-	-	14.75 ± 0.25	31.5 ± 1.85
Brassica	-		4.75 ± 1.70	5.5 ± 1.94	1.00 ± 1.00	1 ± 1.00	-	-
Sorghum	10.25 ± 0.95	12.75 ± 1.89	2.25 ± 1.31	2.5 ± 1.55	2.25 ± 0.25	2.25 ± 0.25	10.75 ±1.25	12 ± 1.87
Millet	9.25 ± 0.95	12.25 ± 1.38	0.75 ± 0.85	0.75 ± 0.48	0.75 ± 0.75	0.75 ± 0.75	8.00 ± 0.71	9.25 ± 1.38
Maize	3.25 ± 0.95	3.25 ± 0.95	5.75 ± 0.48	5.75 ± 0.85	1.75 ± 0.85	1.75 ± 0.85	5.75 ±0.25	6.25 ± 0.63
Chikpea	-		**7.50 ± 1.32**	**9.25 ± 1.93**	3.50 ± 0.87	3.5 ± 0.87	0.75 ± 0.75	1 ± 1.00
Barley	6.25 ± 1.65	6.5 ± 1.89	5.50 ± 0.65	5.5 ± 0.65	0.25 ± 0.25	0.25 ± 0.25	1.50 ± 1.50	1.5 ± 1.50
Wild Vegetation (weeds)								
Cynodon dactylon	5.25 ± 1.84	5.25 ± 1.84	5.75 ± 1.25	6.75 ± 1.25	3.25 ± 1.18	3.5 ± 1.32	7.25 ± 1.38	8 ± 1.83
Desmostachya bipinnata	4.50 ± 1.55	5 ± 1.78	7.00 ± 0.82	9 ± 1.73	1.50 ± 1.19	1.5 ± 1.19	4.50 ± 0.65	5.75 ± 0.63
Achyranthes aspera	3.25 ± 1.89	3.25 ± 1.89	3.5 ± 1.19	3.75 ± 1.25	-	-	6.25 ± 0.63	7 ± 0.82

by bandicoot rat during autumn (9.25 ± 0.95), followed summer (8 ± 0.71) but least in winter (0.75 ± 0.48). Maize crop showed highest frequency of consumption by bandicoot rat during winter (5.75 ± 0.85), followed by summer (5.75 ± 0.25) and spring (1.75 ± 0.85) respectively. Chickpea was most frequently consumed during winter (7.5 ± 1.32), followed by spring (3.5 ± 0.87) and summer (0.75 ± 0.75), respectively. Barley was most frequently consumed during autumn (6.25 ± 1.65), followed by winter (5.5 ± 0.65), summer (1.5 ± 1.5) (Table 3).

Among weeds, khbal gha showed highest consumption during summer (7.25 ± 1.38) followed by autumn (5.25 ± 1.84), winter (5.75 ± 1.25) and least in spring (3.25 ± 1.18). Dhab was more frequently consumed during winter (7 ± 0.81), followed by autumn (4.5 ± 1.55), summer (4.5 ± 0.65), and least during spring (1.5 ± 1.9). The prickly flower was also most frequently consumed during summer (6.25 ± 0.62), followed by winter (3.5 ± 1.19), and autumn (3.25 ± 1.88), respectively (Table 3).

4. Discussion

The bandicoot rat occurs widely in the Pothwar Plateau, associated with the agricultural fields; however, no studies have been focused on the dietary habits of this rat species in this area. Analysis of stomach samples of bandicoot rat from Pothwar Plateau have revealed eight crops and three wild vegetation species consumed. During cropping season, it frequently and heavily wheat groundnut and sorghum. Less frequently it consumed mustard, maize and chickpea. On the side lines, it also feeds upon some fodder crops millet and barley. Among wild vegetation, it consumed three species *Cynodon dactylon, Desmostachya bipinnata* and *Achyranthes aspera*. However, the bandicoot rat did not consume some other vegetation species which are present at the same sites (and collected as reference material) including *Zizyphus nummularia* (Bairi), *Solanum nigrum*, *Erogrotis cynosuroides* (Cane grass), *Eruca sativa* (Taramira), *Medicago sp*., *Artemisia dubia*, and *Chenopodium album*. Previously Lathiya (1990) conducted a similar study in lower Sindh, Pakistan, on stomach contents analysis of bandicoot rat and reported twelve different plant materials in the stomach samples. Among all, grains and leaves of rice were significant, *Scirpus maritimus*, *Paspalidum geminatum* (seeds) and insects. During months of autumn, the consumption of rice leaves became less and grains became more frequent in the diet. In winter (January), 82% part of the rat diet was on *S. maritimus* tubers in the absence of rice. Ismail (1987) had shown that the food composition of rat was 100% on wheat just after the crop harvest. Hussain et al. (2003) and Hussain (1989) revealed that the bandicoot rats in the crops of wheat nearby Islamabad fed upon different parts of wheat crop, its stems and leaves, grains, rhizomes of baron dhab and flower, seeds and rhizomes of khbal gha. From the beginning of the November, Bandicoot started consuming wheat crop and consumption remained till August. In April, wheat grains were accounted in significant amount in the diet of rat species (97%). There was an inverse relationship between wheat consumption and *Desmostachya* rhizomes from November to March. In the current study also, the bandicoot rat consumed baron dhab and khabal gha among three wild vegetation species.

In the Pothwar Plateau, wheat is the major winter crop along with other inter-cropping of brassica and chickpea etc. The sowing stage of wheat starts from early winter (November) and matures in spring (April- May), that's why, diet composition of lesser bandicoot rat showed heavy consumption of wheat during the spring season,

followed by in winter season. Summer and autumn are the non-cropping seasons of wheat, therefore, the rodent species showed no consumption of wheat during these seasons. However, the stomach samples of bandicoot rat did show consumption of some grasses and fodder crops during these months.

If we compare the results of the current study with few previously available published studies, Ismail (1987) had reported that bandicoot rat heavily fed on wheat during the wheat crop season (100% on wheat), and the current study also reports similar results from Pothwar Plateau. Similarly, Hussain (1989) had reported that the diet of this rat species by April was 97% wheat, and this wheat consumption started from the November and remained high till August. Lathiya (1990) studied the stomach contents of 166 bandicoot species trapped from the rice field of lower Sindh, indicated 12 Plant species including rice and also some seeds like those of *Paspalidum geminatun*. Asif et al (1992) found that wheat was present in all the rat samples captured from March to May but in early stages of crops, seeds and rhizomes of some grasses were also consumed frequently and the consumption of wheat decreased as the wheat became mature. Keeping in view all the literature and the current results, it looks likely that the bandicoot rat is basically opportunistic feeder, but it has strong preference for wheat when available during its crop season.

Groundnut is the major summer crop in the Pothwar Plateau, along with the other crops like millet, sorghum, and maize etc. The composition of different food items found in the lesser bandicoot rats diet at sowing stage of groundnut started from summer (June -July) and harvested in autumn (October -December). The stomach samples of bandicoot rat showed more frequency of consumption of groundnut during the summer season, followed by in the autumn. Winter is post-harvest stage of the groundnut crop but some of the samples did show consumption of the groundnut seeds during winter as bandicoot rat species is known for its burrow hoarding activities or after harvest some peanut seeds are usually still remained in the field. Similarly, during non-cropping seasons, stomach samples revealed consumption of some weeds and fodder crops.

In the current study, the lesser bandicoot rat also relied upon some weeds, grasses and some fodder crops during the non-cropping season of wheat and groundnut, at early stages of the crops growth. Hussain et al (2003) had reported that fast growing trees are planted for browse and fodder purposes for the domestic animals, and the diet switches in increasing manner as the crops reach maturity, and according to Hussain (1989), the diet of the rodent species mainly consists of wheat as crop matures. The increasingly utilization of the crops by the bandicoot rats during different growth stages would mean increasing the damage. Grasses are important part of the bandicoot rat's diet when there is no crop around or early stages of the crops. In groundnut and wheat fields, some of the grass species like *Cyanodon dactylon, Desmostachya bippinita,* and *Achyranthes aspera* etc. serve as food for this rodent species until the crop ripening stages. In another study, Asif et al (1992) found the same pattern in the diet of the rat species, that in the fields of rice, the grasses *E. setaria* and *Dactylocteneum* served as alternate food until the rice grains matured.

5. Conclusion

The study concludes that in the Pothwar Plateau, the lesser bandicoot rat consumes eight different crop species, opportunistically, in varying proportions, while it also supplements its diet with three different weed species, when crops are not/less available. However, three main crops consumed by lesser bandicoot rat in the current study (in preference order) include wheat, groundnut and sorghum.

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