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Food and Feeding Activities of Rhesus Monkey (*Macaca mulatta* Zimmermann 1780) in Different Altitudinal Habitats in Nepal

Ram Chandra Adhikari*, Kaushik Chakraborty

Department of Zoology, Raiganj University, West Bengal, India
*Email: ramchandraadhiari8@gmail.com

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Abstract

Data on food and feeding activities are crucial for a deep understanding of monkey's behavioral responses and adjustment to a particular habitat. The study aimed to find the food plant species, preferred parts, and food composition from May 2022 to April 2023 in three altitudinal varied habitats- Ramdhuni, Dharan, and Dhankuta of eastern Nepal. One troop of Rhesus monkeys was selected in each habitat, and a total of 2754 hours was spent observing the feeding behavior. Data were collected using the focal animal sampling method. There was a decrease in the occupancy of tree food species with an increase in the height of the habitat by 60.63%>51.02%>42.62%. There was a variation in the availability of food items with the changes of season in Ramdhuni, and there was no significant difference between Dharan and Dhankuta. A significant relation of food composition according to season change was found. The monkey preferred mostly fruits in all habitats. The most selected plants by monkeys were also analyzed. The number of parts of the plant eaten and time spent were well correlated except for the herbs in Dhankuta. In most cases, the availability of food items and their occupancy in food composition were positively correlated. Our results suggest planting plants in forests and bare areas to reduce human-monkey conflict.

Keywords: Adaptation, Dhankuta, leaf, season, time investment, tree

Introduction

The Rhesus monkey (*Macaca mulatta* Zimmermann 1780) is one of the most common, widely distributed, and ecologically adaptable primate species in the world and is distributed mostly in Bangladesh, India, Pakistan, Nepal, Myanmar, Thailand, Afghanistan, southern China, and a few nearby regions (Green, 1978). Nepal ranges from low land to higher mountains (2500 masl)

(Chalise, 2013). Changes in altitude, along with the topography, climate, and vegetation, determine animal diversity and relate to its behavior (Smith, 1974). Many variables fix the activities of primates, such as endogenous timing systems (Hut, Beersma, 2011) and natural habitats and environmental factors (Lincoln et al., 2003). The factors belonging to the food- quality of food, abundance, occupancy, food source plants, and their distribution and seasonal variation shape the temporal distribution, feeding activities, and other activities of primates (Hanya, 2004; Matsuda et al., 2009; Korstjens et al., 2010; Sha, Hanya, 2013).

The food items and environmental factors impact the activity budgets, including the feeding behavior of primates (Majolo et al., 2013; McFarland et al., 2014). The primates show a wide range of dietary and behavioral adjustments to fill up sufficient food in the scarcity (Serckx et al., 2015; Clink et al., 2017). Food has a sound impact on primate adjustment in the habitat (Altmann, 1991), which is promoted by the flexibility of foraging strategy in different habitats (Cui et al., 2019; Green et al., 2020). The Rhesus monkey plans the strategies for maximizing energy from available food resources (Zang et al., 2021). Primates try to consume fruits maximally up to their availability because fruits are considered higher-quality food items that contain high sugar, are easier to digest, and are quickly converted to energy (Richard, 1985; Lambert, Rothman, 2015). Food availability in the source plants for particular species drives the feeding policy (Bessa et al., 2015). The monkeys, in general, have been described as frugivorous animal (Yeager, 1996; O Brien, Kinnaird, 1997; Riley, 2007), but they feed on other parts of plants (leaves, fruits, flowers, seeds, bark, shoot), besides these occasionally they eat invertebrates and their larval forms (Chalise, 1997; Chalise, 2008; Chalise et al., 2005) and also amphibians, reptiles, birds (Schulke et al., 2011). All monkeys choose their meal based on their eating patterns, the availability of foods, and the nutrients they contain (Chalise, 2000).

The research on Rhesus monkeys had been carried out in Bandhipokhari Palpa, Shivapuri National Park, Nagarjun forest (Ghimire, 2000; Bashyal, 2005; Rijal, 2015) in Dhankuta (Adhikari, 2018) in Dharan (Tamang et al., 2020) in Ramdhuni (Adhikari, 2023) in Ramdhuni, Dharan, and Dhankuta (Adhikari, Chakraborty, 2024). However, no work has been done on the comparative analysis of feeding activities in different altitudinal habitats. Food species identification, the composition of food, the preference of plant parts, and the relation of time to the composition of food-like parameters have not been explored in our focused field. So we aimed to point out Rhesus monkey's food plants, their preferred parts, the composition of food, the relation of the

composition of food, and the availability of food items. The study on the dietary flexibility of Rhesus monkeys in habitats of different altitudes will help to understand more deeply the potential practices of adaptation of this species (Zang et al., 2023). Also, studying feeding behavior is crucial because it gives the idea of food plants, the most loved items, which would be supportive for reducing Human monkey conflict and management of this overpopulated and big crop raider species.

Material and methods

Study Area

Three study sites, the monkeys' natural habitat, were selected after a few months of survey. These three habitats have different climates, topographic, and other features. They are 50 kilometers apart, so the monkey cannot visit the next habitat. Ramdhuni forest is dominated by Sal tree vegetation and is situated in Sunsari district, Koshi province, Nepal. It is at 26° 41' 23" N and longitude 87° 7' 44" E. It offers a Monsoon-influenced humid subtropical climate (Minidat, 2023). The annual temperature ranges from 10^0 C to 40^0C and receives 1600 mm of precipitation (Ramdhuni et al., 2022). The heavenly Hindu sanctuary is found within the center of this spiritual woodland, and it is also known as Ramdhuni (Dhuni). Around 20.4 sq. km of Ramdhuni woodland is approximately 10 km east of Koshi Tappu Wildlife Reserve and the Koshi River (the largest river of Nepal). Around the edge of this woodland, there are human settlements and farming. Individuals ordinarily utilize the entertainment center within the woodland. Seraha Stream and Sunsari Waterway pass through the forest (Dahal et al., 2016).

Dharan forest is at 26.69 0 N and 87.17 0 E in the Sunsari district of Koshi province, Nepal. The study area lies at an altitude of 428 meters above sea level. It is a tropical natural forest. Temperatures range from 140 C to 350 C, and annual rainfall is 1796 millimeters (Dharan municipality, 2023). The next study area, Dhankuta, is situated in the Dhankuta district in the Mahabharat range. The municipality covers a geographical area of 111.6 sq. km. It is situated between 26°59’59’’ and 27°02’55’’ North latitude and 87°17’52’’ and 87°23’09’’ East longitudes. The elevation ranges from 250 masl to 2144 masl. The temperature ranges from 12^0 C to 30^0 C, and the annual average rainfall is 2603 mm (Dhankuta Municipality, 2022). The study was focused on elevation above 1000masl. The study area has temperate forest vegetation. A well-preserved forest (Chuli Ban) spreads along a ridge line on the northwest side with well-developed mature

stands of rhododendron and Sallo (Pine) trees. Locating towards the northwest of the main town is 'Salleri Ban', which, as the name suggests, comprises mainly Pine trees (Subba, 2023). In both the study areas, seasonal changes occur, and four distinct seasons can be observed. They are spring (March- May), summer (June- August), autumn (September- November), and winter (December- February).

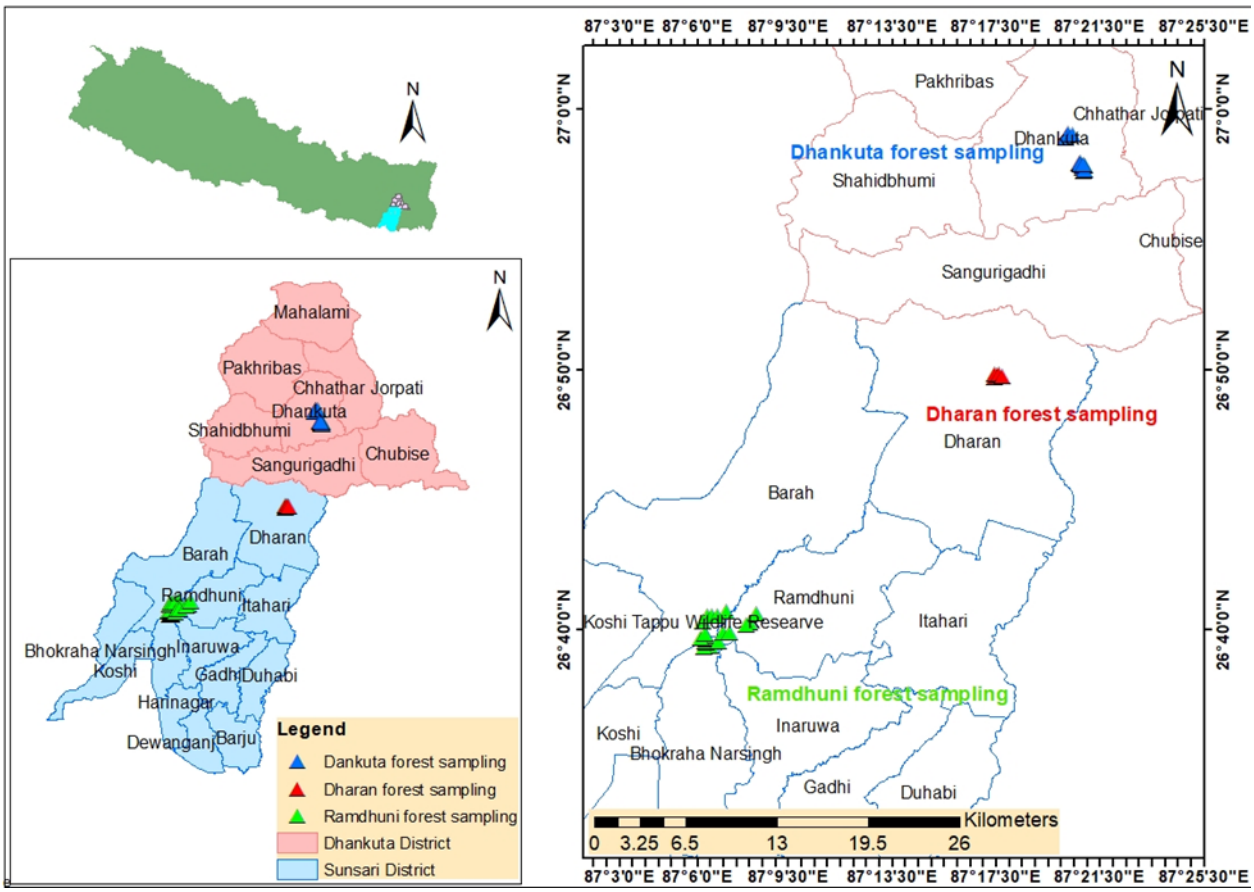

Figure 1. Study area

Troop selection and Population composition

A group of monkeys was often sighted in the jungles of Ramdhuni, Dharan, and Dhankuta for a few days. We identified individual animals based on marking color, body size, tail size, behavior, and group leadership. Attributes such as height, body size, body color, and body proportion made the troop clearly recognized (Roonwal, Mohnot, 1977; Chalise, 1995). The troop's members were classified as adult males, adult females, young and sub-adults, juveniles, and neonates (infants) based on their physical characteristics, color, and behavior (Chalise, 1995). In light of this: 1. Adult males: Their defining characteristic was the big, dangling scrotal sacs on adult males. 2. Adult females: They can be identified by their prominent nipple and short head.3. Young and sub-adults:

They are self-sufficient and have typically reached adulthood but are immature regarding sexual and physical development. 4. Juveniles: These are the people who have been weaned and left with no breast touch; they mostly rely on natural foods and family ties.5. Infants: These are the ones who still use their mother's nipple as their primary food source when they cling or follow her. As a result, we classified infants, juveniles, and sub-adults as immature. The focal troop in Ramdhuni had 61 members, 19 males, 27 females, and 15 immature. The total population of the selected troop in Dharan was 32, with 9 males, 16 females, and 7 immigrants. The focal troop in Dhankuta had 23 members, 7 males, 11 females, and 5 immature.

Behaviour documentation

The period of observation was May 2022–April 2023. Ten days of field visits were scheduled for each research location each month as the prior researchers (Kumar, Solanki 2003). The period used to capture behavior started before sunrise and ended after nightfall. The number of hours observed each day varied from nine to thirteen. For every location, 110 days were allocated for jungle visits. In total, 2754 hours were spent watching monkeys, with 918 hours in each study region. In the outdoor investigation, one adult focal animal was continuously observed for 60 minutes (Altman, 1974), and if it disappeared or was out of sight, point attention was turned to the next focal individual (Chalise et al., 2013; Ghimire et al., 2021). A total of 42 focal animals were taken in sight. The focussed animal's behavioral patterns and group members' actions toward it were documented. Before the observation, a randomized sample of the adult population was taken. Stop clocks were used to determine and control the time.

Through direct observation in the field, data on the feeding habits of Rhesus macaques, including food plants, food items, and meal periods, were collected using the same approaches as (Chalise et al., 2013). Feeding is combined activities like handling food, manipulating, chewing, and swallowing food items (Neha et al., 2021). Besides this, the datasheet included a list of the several food plants and plant parts that the adult and immature Rhesus macaques ate, including fruits, flowers, shoots, buds, seeds, bark, resin, pods, and leaves. The preferred parts of plants were also noted on the notebook/datasheet.

Data Analysis

Using a similar method, we generated statistics on dietary data, figuring out the diet composition as percentages of particular food species or categories consumed throughout the feeding period

(Huang et al., 2015). The number of parts eaten from particular plant species, the number of months the monkey consumed the products, and the number of months in which the availability was also documented. The percentage of feeding time on a particular plant species was calculated by time spent in the particular species X 100/ total time spent in feeding. The annual preference ratio (The ratio of feeding months and availability of preferred part) was calculated in Microsoft Excel 2016. Nine food items (plant parts) were considered for the study, and their source (tree, shrub, and herb) was also expressed in percentage. Correlation, Chi-square, and ANOVA were also calculated and analyzed in Microsoft Excel 2016. Out of the whole feeding time, the time spent on plants was taken as a cent percentage, and based on this, time allocated for each item of plants was calculated.

Results

Food species

Out of all eaten species of plants, the Ramdhuni tree occupied 60.63%(n=57), shrub 24.46%(n=23), and herb 14.89%(n=14) in food the Rhesus monkey. The food items from vegetation were also recorded throughout the year in four seasons. There was a variation in the availability of food items with the changes of the season (Chi-square calculated =39.56, tabulated= 36.41, df= 24 at significance level 0.05). In the Dharan habitat, out of all eaten species of plants, trees occupied 51.02%(n=25), shrubs 20.40%(n=10), and herbs 28.57%(n=14). The food items from vegetation were recorded throughout the year in four seasons. There was no significant difference in the availability of food items in vegetation in different seasons in Dharan (Chi-square calculated =22.23, tabulated= 36.41, df= 24 at significance level 0.05). In Dhankuta, out of all vegetation on which the monkeys fed, the trees occupied 42.62%(n=26), the shrubs 29.50%(n=18), and the herbs 27.86%(n=17). The food items from vegetation were recorded throughout the year in four seasons. There was no significant difference in the availability of food items in vegetation in different seasons (Chi-square calculated =25.12, tabulated= 36.41, df= 24 at significance level 0.05) in Dhankuta. There was a decrease in the number of food species with an increase in the height of the habitat by 60.63%>51.02%>42.62% on behalf of tree species. The shrub and herb food species were not in a fixed pattern. The shrub food occupancy decreased from Ramdhuni to Dharan and increased to Dhankuta. Herb occupancy was maximum in middle-height habitat.

Food composition by time

In Ramdhuni, the food of the Rhesus monkey was composed of 73.25% of trees, 24.75% of shrubs, and 2% of herbs. The Rhesus monkey's food was mainly composed of the parts of tree species *Sorea robusta* (6.5%), *Alangium salviifolium* (3.5%), and *Terminalia alata* (3%), respectively. Similarly, in shrub species *Justicia adhatoda* (3%), *Rauvolfia serpentiana* (2.5%) and *Murraya koenigii* (2%) respectively. The herbs were less preferred, equally as *Hemigaphis hitra*, *Eclipta prostrata* and *Centella asiatica* (0.25%). The season-wise composition of food was also recorded and analyzed. In Ramdhuni, there was a good relation between season change and the composition of the food of the Rhesus monkey (Chi-square calculated = 50.692, tabulated = 32.67, df= 21 at significance level 0.05). In Dharan, the food of Rhesus monkey consists of trees of 79.5%, shrubs of 15.25%, and herbs of 5.2%. The Rhesus monkey's food was mainly composed of the parts of tree species *Symplocos ramosissima* (10.25%), *Alangum salviifolium* (7.75%), *and Mangifera indica* (7.25%). The major shrub species to which the monkeys spent most of the time feeding were *Justicia adhatoda* (2.5%), *Lantena camera* (2.25%), and *Cassia sophera* (1.75%) respectively. In herbs, the major component species of food for monkeys were *Amaranthus* (1.5%), *Euphorbia teresophylla* (0.70%), and *Bidens* sp (0.6%), respectively. The seasonal variation in food composition was also analyzed in Dharan, and these were closely related (Chi-square calculated= 51.011, tabulated=32.67, df =21 at significance level 0.05).

In Dhankuta, the food of Rhesus monkeys was made up of trees 68.1%, shrubs 18.8%, and herbs 13.1%. The tree species on which the Rhesus spent most time for food collection and eating were *Pinus roxburghii* (11.25%), *Alnus nepalensis* (7%), and *Oroxylum indicum* (4%). Among shrub species top most components of food were *Fragaria nibucola* (2.25%), and all three species *Lantena camera, Lantena* sp., and *Thysanolaen latifolia* (2%). Finally, among herbs, the monkey's food composition contained mostly Bans (3%), *Depanostachyum falcatum* (2.5%) and *Nephricepis cordifolia* (1.15%).

The seasonal variation in food composition was also analyzed in Dhankuta, and the results were closely related (Chi-square calculated = 62.15, tabulated = 32.67, df =21 at significance level 0.05). The season-wise variation of the composition of food items in all three different altitudinal habitats was analyzed and expressed in the following figures (Fig. 2 to 9).

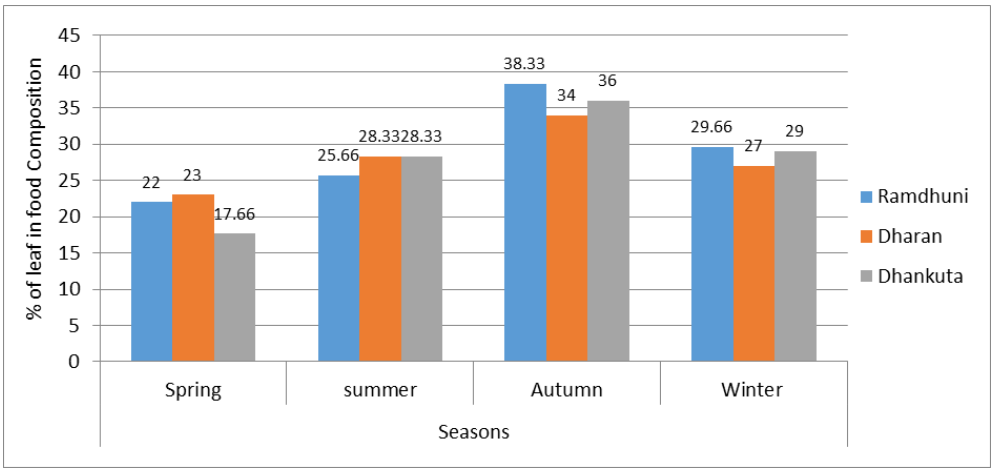

Figure 2. Season-wise variation of leaf in food composition

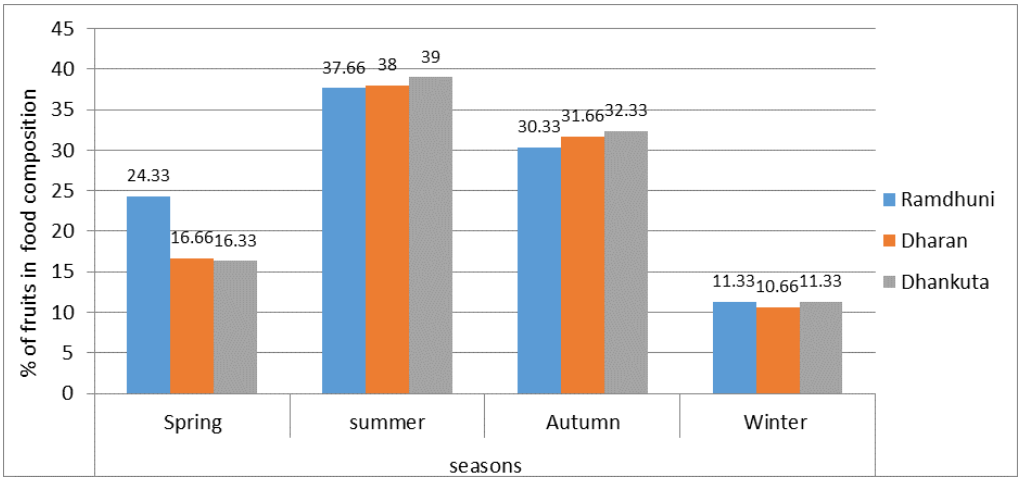

Figure 3. Season-wise variation of fruit in composition of food

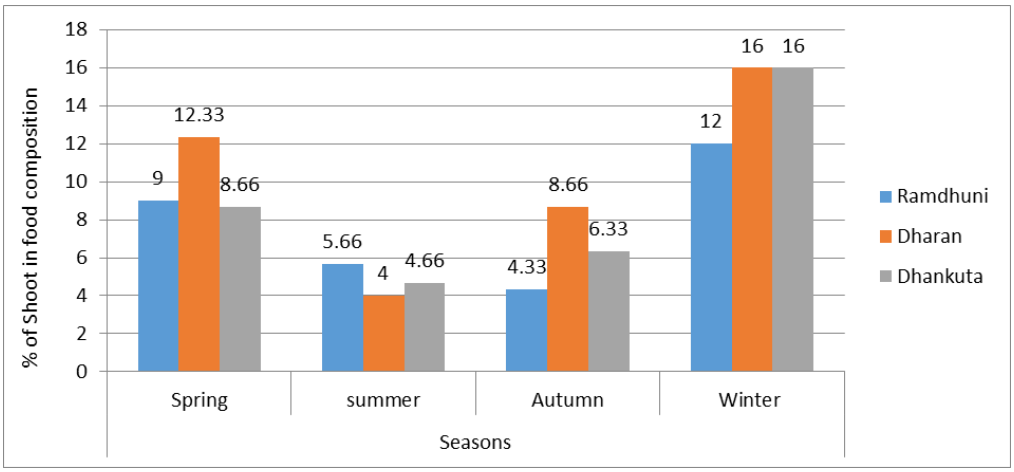

Figure 4. Season-wise variation of the shoot in the composition of food

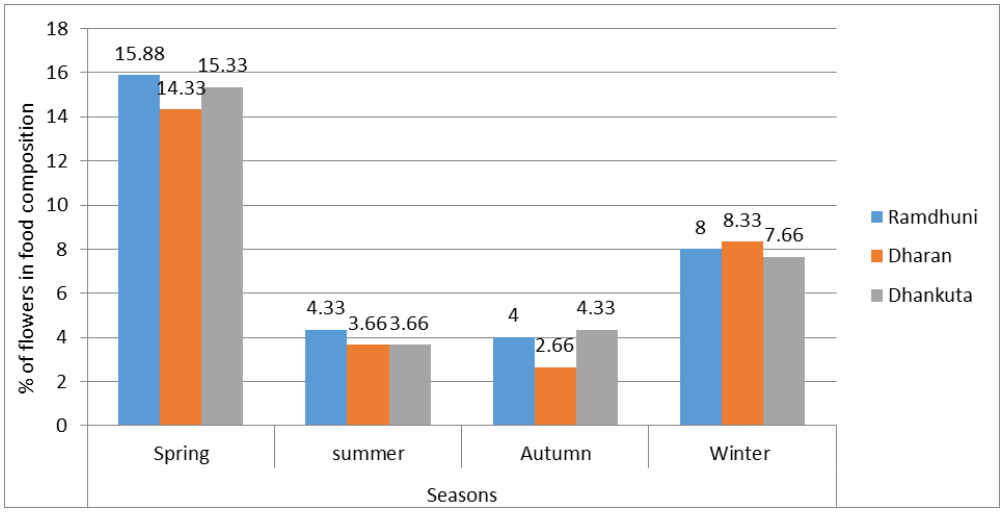

Figure 5. Season-wise variation of flower in food composition

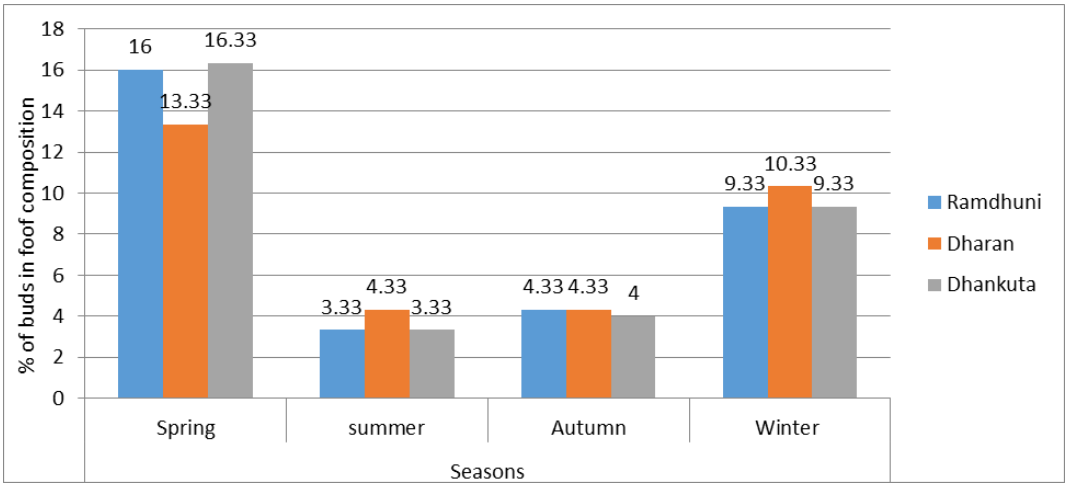

Figure 6. Season-wise variation of bud in food composition

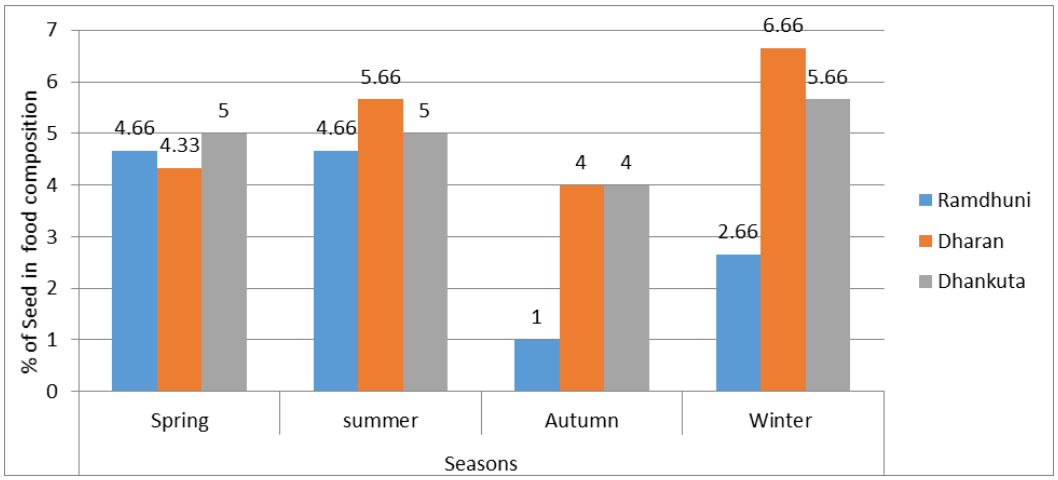

Figure 7. Season-wise variation of seed in food composition

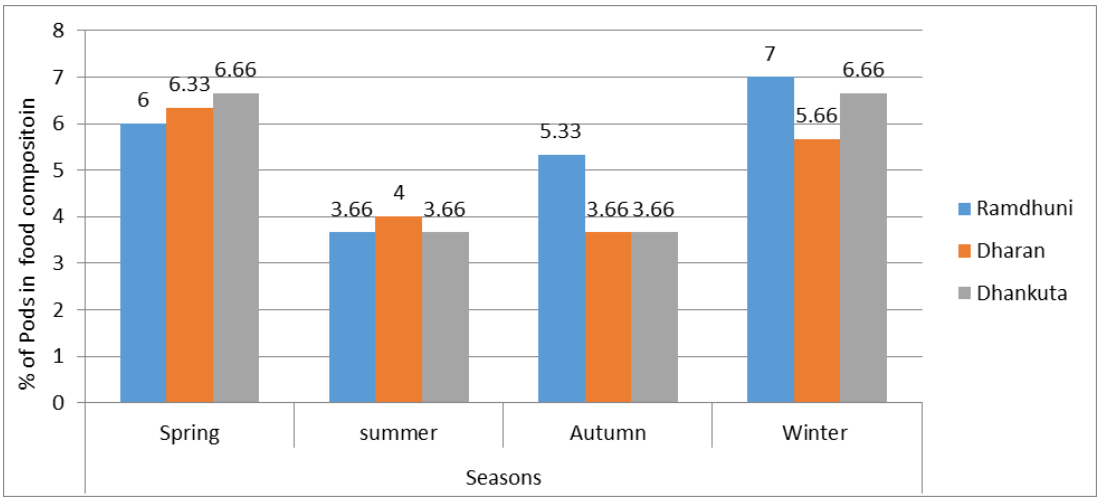

Figure 8. Season-wise variation of pod in food composition

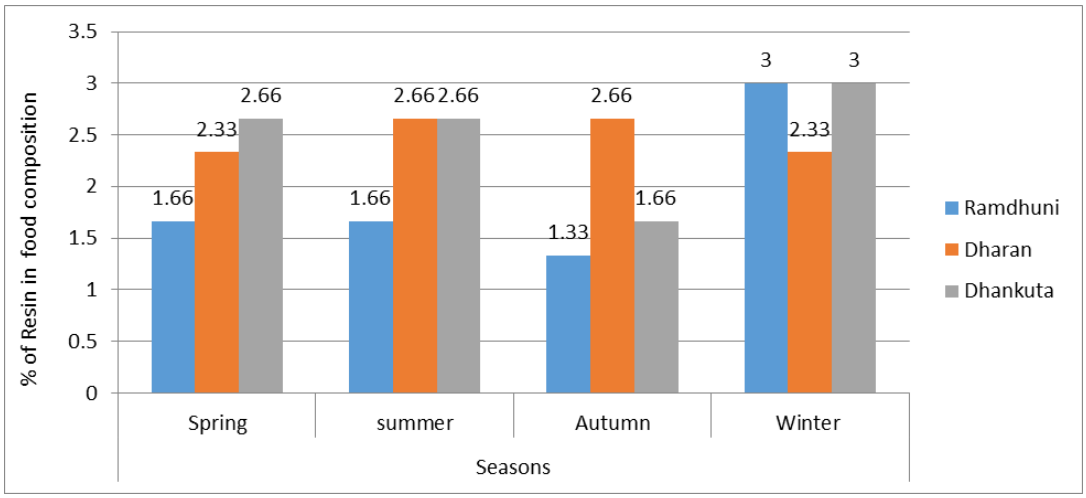

Figure 9. Season-wise variation of resin in food composition

Preferred parts from plants

Ramdhuni: Leaf was preferred from 19 species(33.33%) of the tree, 15 species of shrub (65.21%), and four species(28.57%) of herbs. Fruit was preferred from 20 species (35.08%) of the tree, five species (21.73%) of shrubs, and nil from the herbs. Flowers preferred from 6 species (10.52%) of the tree, three species (13.04%) of shrubs, and nil from the herbs. The shoot was preferred by seven species (12.28%) of the trees, nil from shrubs, and eight (57.14%) herbs. The pod was preferred from 2 species (1.75%), seed, bud, and resin from 1 species (1.75%), and not these three items from the shrub**.**

Dharan: Leaf was preferred from 4 species of tree (16%), two species of shrub (20%) and seven species of herb (50%). Fruit is preferred from 11 species (44%) of trees, two species of shrubs (20%), and nil from the herbs. Flowers preferred from 12 species (48%) of tree species, one species (10%) of shrub, and one species (7.142%) of herb. Shoot preferred two species (8%) of trees, two species (20%) of shrubs, and five species (35.71%) of herbs. Pod preferred from 1 species (4%) of the tree, one species (10%) of shrub, and nil from herbs. Seed preferred from 1 species (4%) and one species of shrub (10%) and not from herbs. Bud and resin were not found in the preference.

Dhankuta: Leaf was preferred from 1 species (3.84%) of the tree, one species (5.55%) of shrub, and three species (17.64%) of herbs. Fruit was preferred from 12 species (46.15%) of the tree, four species (22.22%) of shrub, and no herb. Flower was preferred by four species (15.38%) of trees, 4 species (22.22%) of shrubs, and three species (17.64%) of herbs. Shoot was preferred by 2 species (7.69%) of tree, three species (16.66%) of shrub, and ten species (58.82%) of herb. The pod was preferred from only one species (3.84%) of the trees and not from shrubs and herbs. The seed was preferred from 3 species (11.53%) of the tree, one species (5.55%) of shrub, and 1 species (5.88%) of herb. Bud from only one species (5.55%) of shrub and resin from only one species (3.84%) of tree species, not shrubs and herbs.

Species whose most of the parts eaten

We observed the monkey eating the parts of the plants and recorded which parts were consumed by monkeys. Here, we mentioned vegetation species whose three or more parts were consumed by monkeys.

Ramdhuni: In Ramdhuni *Bombax ceiba* was come in the first tree species whose four parts (bud, flower, fruit and bark) were eaten. Similarly, three parts of each *Mangifera indica* (flower, fruit and resin), *Sorea robusta* (flower, fruit, and leaf), and *Lagerstoemia parriflora* (flower, fruit, and bark) were found eaten by monkeys.

Among shrub species, there are three parts of each species, *Justicia adhotoda* (leaf, shoot, and fruit), *Rauvolfia serpentina* (leaf, shoot, and fruit). Among herbs, most parts (three parts- Bidens sp) were found to be consumed by monkeys.

Dharan : In Dharan, two species of tree came in first, whose four parts were consumed by monkeys. They were *Bombax ceiba* (parts eaten- bud, flower, fruit and shoot) and *Alangium salvifolium* (parts eaten- leaf, shoot, seed and flower). *Sorea robusta, Bauhinia pururea, Albizia lebbeck, Albizia julivrissin, Syzygium cuminili and Eucalyptus camaldulensis* stood in second

position, three parts of which were consumed by monkeys. Among shrubs in Dharan, four species of plants have equal scores, i.e., their two parts were eaten by monkeys. They are *Justicia adhotoda* (leaf and shoot), *Rauvolfia serpentina* (leaf and shoot), *Pogostemon benghalensis* (leaf and shoot) and *Leera robusta* (leaf and shoot). Regarding the herbs *Amaranthus* sp.(leaf, shoot and flower) and *Bidens* sp.(leaf, shoot, and flower) came to the first position as their three parts were found consumed by monkeys.

Dhankuta

In Dhankuta, we recorded *Alnus nepalensis* as the only tree species whose three parts (fruit, shoot, and seed) were consumed by monkeys. Among shrubs, six species came in front, and two parts were consumed. They were *Lantena* sp (fruit and flower), *Lantena camera* (fruit and flower), Bhogate (fruit and flower), *Rhus chinesis* (seed and leaf), *Woodfordia frucicosa* (fruit and flower) and *Berberis aristata* (fruit and flower). In the case of herb consumption, three parts of two species were consumed maximally. They were Agerantum concedes (Flower, shoot, and leaf) and *Euphorbia hirta* (flower, shoot, and leaf).

Relation between the number of parts eaten and time spent on the species

In Ramdhuni, there was a close relation between the number of parts of plant eaten and time spent on that species in all trees, shrubs, and herbs (for tree r= o.324626, for shrub r= 0.527955445 and herbs r= 0.84898231). In Dharan, there was a close positive relation between the number of parts of plant eaten and time spent on that particular species in all trees, shrubs, and herbs (for tree r= 0.3184, for shrub r = 0.2307, and herb r= 0.6637). In Dhankuta, there was a positive, close relation between the number of parts eaten and the time spent in that particular plant (for tree r= 0.377, for shrub r= 0.3848), and no relation or negative relation was found regarding herbs (r= -0.0244).

Relation between the composition of food and availability of a particular item

The food item (leaf) was analyzed for availability and occupancy in total food. In Ramdhuni, the correlation analysis showed a negative relation between these two parameters (r= -0.1088). In Dharan, there was also a negative relation between the availability of leaf and its occupancy in food (r=-0.808). In Dhankuta, the same result was noticed (r= -0.3190**).** Regarding fruit, there was a very close relation between the availability of fruit and its occupancy in food in all habitats (Ramdhuni r= 0.972, Dharan r= 0.962, and Dhankuta r= 0.896). In the case of flowers, there was a positive relation with their occupancy (Ramdhuni r= 0.8083, Dharan r= 0.932, and Dhankuta r= 0.952). In the case of the shoot, there was a different result. In Ramdhuni, there is a negative

relation (r= -0.139); in Dharan and Dhankuta, they were positively correlated (Dharan r= 0.862 and Dhankuta r = 0.156). In the pod, it was positive in Ramdhuni (r= 0.429) and negative in both Dharan (r= 0.567) and Dhankuta (r= 0.707). Regarding seeds, the availability of it the composition of food showed negativity in Ramdhuni (r= 0.923) and positive in Dharan (r= 0.773) and Dhankuta (r= 0.2923). The correlation of availability of buds in different seasons and its holding showed positive in Ramdhuni (r= 0.124), negative in Dharan (r=-0.555), and positive in Dhankuta (r=0.1198). The resin was also a food item that positively related to the availability and inclusiveness in the food of monkeys in all three habitats (Ramdhuni r= 0.523, Dharan r= 0.577, and Dhankuta r= 0.960).

Discussion

Our results showed that food occupancy by tree species decreased with habitat height (60.63%>51.02%>42.62%). Shrub food occupancy decreased from Ramdhuni to Dharan and increased to Dhankuta. Herb occupancy was maximum in the middle-height habitat (Dharan).

Macaques consumed 193 foods, including 11 food categories and 90 species (Zhang et al., 2023). Our finding contrasted with the results of more plant species consumed at higher altitudes (Grueter et al., 2009; Tsuji et al., 2013). Primates respond to food shortages by increasing the variety and number of plant species in their source (Hill, 1997). The researchers found that Rhesus macaques fed on 107 food items, including leaves, flowers, fruits, seeds of different species, and insects (Sengupta, Radhakrishna, 2016). It was documented that the focal Syangja troop under investigation used 71 plant species (45 trees, 11 shrubs, 10 herbs, and five climbers) (Ghimire, 2023). Not matching this, the research findings showed a seasonal variation of food plants and their parts. The preservation of native plants and trees is essential to the survival of grivet monkeys, as their preferred food source, tree species, is under threat (Alelign et al., 2023). The food of Hamadryas baboon comprised 52 food species from three animal families and 22 plant families. 8.8% of their food came from food they stole from neighboring farms (Ibrahim et al., 2023). The black-and-white snub-nosed monkeys consumed 94 species of plants (Grueter et al., 2009), and Pan troglodytes consumed 102 species (Watts et al., 2012). The Japanese macaques consumed 93 species of plants in Yakushima (Hill, 1997). The Rhesus monkey in a semi-disturbed habitat consumed 36 species of plants and the great majority of food from herbs, i.e., 35 species in India (Tomar, Sikarwar, 2014).

Our result showed that the occupancy of trees and shrubs on food of Rhesus monkeys was maximum in low habitats (Ramdhuni), and the occupancy of herbs on food was maximum in high altitudinal habitats (Dhankuta). In the major three food sources, one tree species *Alangium salviifolium,* was common in two habitats (Ramdhuni and Dharan), one shrub *Justicia adhatoda* was common in Ramdhuni and Dharan, and *Lantena camera,* was common in Dharan and Dhankuta but not common herbs at all. The food composition varied according to the season change. Just oppositely, in Bangladesh, the marque group consumed grasses maximally (41.9%) (Sarker et al., 2008). The food composition varied according to the variation of plant species and part eaten (Hanya et al., 2003; Harris, Chapman, 2007). It is supported by an example of Japanese macaques in different zones (Hanya et al., 2003), and food resources' spatial and temporal availability determines food composition (Hanya, 2004). A sound effect of seasonality was observed in the food composition of the Assamese monkeys in mid-hill Nepal (Ghimire, 2023). Matching this, Assamese macaques of Nonggang Nature Reserve, China, allocated much time to feeding with less food availability in the dry season (Zhou et al., 2007). Monkeys use different quality of food from different sources according to the seasonal variation (Zhou et al., 2006).

However, climate change has significant effects on plant phenology and vegetation structure (Chapman et al., 2005). Hence, we believe there may not be a permanent way and cycle to consume food in seasonal variations. Quantity of fruit production in different season becomes more important to determine the diet of primates (Dunn et al., 2010). Seasonal variation in diet of Assamese macaques was clearly linked to the seasonal fluctuation in food availability (Ghimire, 2023). It was widely demonstrated in primates (Overdorff, 1993; Atsalis, 1999; Simmen et al., 2003; Norsica et al., 2006). The animal's diet varied their diet in relation to changes in the seasons in availability (Guo et al., 2007). There was some matching to our findings in that the researchers found no significant seasonal variations in food consumption by Rhesus monkeys (Ganuly, Chauhan, 2018). Our findings showed that the fruit was the most preferred part in all the habitats. The choice of the rest of the items was not fixed in the diagrammatic pattern.

The Rhesus monkey depended on wild food from plant resources only 27.45%, and fruits were the best choice (45.11%), which was followed by leaves (23.21%) (Tomar, Sikarwar, 2014). That result shows the similarity to us. Contrarily it, other results showed that the macaques mostly choose leaves and stems. The most loved plant species were *Prosopis juliflora* (16.34%) and *P. cineraria* (11.09%) (Ganguly, Chauhan, 2018). In many research studies, fruit was the best choice,

but in many cases, the provisioned food lowered the chances of choosing fruits (Hambali et al., 2014). The part chosen might vary even in the same season. With the result above, a study stated that the monthly variation in food plant preference and diet composition within a season became evident (Kumar, Solanki, 2003). Most primates are frugivorous and feed priority on fruits that have juicy, soft pulp, acting as seed predators for those with no discernible pulp (Sengupta, Radhakrishna, 2015).

In three different habitats, the monkey selected some plants, of which they consumed most of the parts. There were some common species, too. For example, *Bombax ceiba, Jusicia adhotoda, amaranthus,* etc. We mentioned the species of plants whose parts were selected the most. The Reshus selected some important parts of plants, but the researchers did not mention which parts mostly selected from which plants. Some groups selected *Carissa opaca, D. sissoo, C. dactylon and Z.mauritiana, s*ome preferred *Buxus papilosa, Carissa opaca, Cassia fistula, Ficus bengalensis* and *Ficus religiosa,* and some groups most wanted *Acacia nilotica, Carissa opaca and D. sissoo, A. nilotica, A. modesta, A. lebbek, Asparagus officinalis, C.sativum, Carissa opaca, D. sissoo (*Aslam et al., 2022). In the study in Florida, the Silver River macaques consumed mainly leaves and some parts from different plants (87.5%) (Riley, Wade, 2016).

We calculated and confirmed that the Rhesus monkey spent the maximum time to which plants had a higher number of parts eaten. But in Dhankuta, in case only of herb, it was not applicable.

The monkey showed a positive relation to the availability of food items at the given time. They preferred some parts showing a close relation, but some parts, even though sufficiently available, the monkey ignored. The significant foods were positively correlated with their availability, but fallback foods were negatively correlated (Marshall, Wrangham, 2007). The matured leaves and lichens were lichen were positively correlated with the availability of preferred foods (Zang et al., 2023). Japanese monkeys in Kinkazan used more bark and herbs in situations where low temperatures were low (Agetsuma, Nakagawa, 1998; Tsuji et al., 2006). The Rhesus macaque was found to be dependent on herbs and roots, which accounted for 23.7% of their food in winter (Goldstein, Richard, 1989). In some seasons, lichens occupy an important part of primates' diet (Tsuji et al., 2013).

Conclusion

This study of three different habitats over a year concluded that altitude might have some effects on the feeding behavior of Rhesus monkeys. There was a decrease in the number of food species

with an increase in the height of the habitat by 60.63%>51.02%>42.62% on behalf of tree species. The shrub and herb food species were not in a fixed pattern. The occupancy of trees and shrubs on food of Rhesus monkeys was maximum in low habitats (Ramdhuni), and the occupancy of herbs on food was maximum in high altitudinal habitats (Dhankuta). The food composition varied according to the seasonal change, and some common species existed at all three heights. Our findings showed that the fruit was the most preferred part in all the habitats. The choice of the rest of the items was not fixed in the diagrammatic pattern. The monkeys selected some plants and consumed most of the parts mentioned in the results. They spent maximum time determining which plants with more parts were eaten. Nevertheless, in most heights, it was not applicable only in the case of herbs. The monkey showed a positive relation with the availability of food items. They preferred some parts showing the close relationship, but in some parts, even though they were sufficiently available, the monkey ignored them. Our results highlight that the Rhesus monkeys adapted well in different altitudes by choosing available foods in the habitat and managing items and the percentage of items from plants.

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