



## Diet of Indian flying fox *Pteropus giganteus* (Brünnich, 1782) in Bhavnagar and Ghogha Taluka, Bhavnagar, Gujarat, India

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### Abstract

Chiropterans, the second vast groups of mammals in the planet which divided in to two group namely megachiroptera and microchiroptera. More than 1400 species representing a zone of the kingdom of Animalia, in which India favoured enough to have 120 bat species. In India, pteropodidae family consist 14 species and out of the 14 only 3 species of fruit bat reported in Gujarat. *Pteropus giganteus* is the most dominant species among this 3 fruit bat species. A feeding and foraging study of the diet of *Pteropus giganteus* in selected two taluka of Bhavnagar district, Gujarat, India was carried out during March 2020 to March 2021. Diet of *Pteropus giganteus* was discover by using the guano/bolus, additional leftover fruits and leaves under the roost sites. Total 28 species of flora were identified as the food plants of *Pteropus giganteus*. Maximum number of food plants were recorded from different feeding and roosting sites of Ghogha (26) whereas Bhavnagar provided the minimum number of food plants (23). Among the food plant species, *Ficus benghalensis*, *Manilkara zapota* and *Ficus racemosa* were the primary food plants of Indian Flying Fox followed by *Terminalia catappa*, *Psidium guajava*, *Ficus religiosa*, *Azadirachta indica*, Plant species namely *Syzygium cumini*, *Ziziphus mauritiana*, *Tamarindus indica*, *Spondias pinnata*, used minimum. It was notice that *Pteropus giganteus* in the study sites favour the ripe fruits rather than the unripe fruits. Indian Flying Fox be depended on mostly fruits (80%) and also ingest other food items like nectar (3%), tender (3%), leaves (10%) and flower (4%). Most Significantly *Pteropus giganteus* predominantly ingest more foods from the cultivated plants species than the other wild plants species and it directs the bats to have dispute with farmers. *Pteropus giganteus* is categorized in schedule II of Wildlife (protection) Act in the country and Least concern (LC) as per IUCN list of threatened species.

**Keywords:** Bolus, Diet, Indian flying fox, seed dispersal agent

### Introduction

Bats are one of the flying mammals, they are most important and least understood group of the animal world (Bhandarkar and Paliwal, 2014) [3]. Bat come under order chiroptera, the most specious order of mammals after the rodent, exhibits a great physiological and ecological diversity (Srinivasulu *et al.* 2010 [23]; Purohit *et al.* 2013 [21]; Bhandarkar and Paliwal, 2014) [3]. The feeding habits of bats varied from other mammals. Dietetic variation of bats shows morphological, and ecological diversity (Altring-ham, 1996). The fruit bats are virtually phytophagous, consuming different plant resources such as pollen, nectar, petals and leaf (Marshall, 1985) [17].

Bat play important role in the ecosystem and two family of bat such as Pteropodidae and Phyllostomidae play the significant role in plant pollination and seed dispersal that provide an important ecological service by providing the reproductive success of plant species (Kunz *et al.* 2011) [14]. The *Pteropus giganteus* is the foremost pollinators of several nectariferous plants which bloom only at night (e.g. *Ceiba pentandra*, *Bassia latifolia*) and they are major effective than birds in seed dispersal by covering larger distance at night. While their defecation seeds during flight encourages the genetic exchange among the fragmented and isolated population forest and therefore decreasing the chances of interbreeding (Loveless and Hamrick, 1984 [16]; Kasso and Balakrishnan, 2013) [13]. In orchard and crops such as banana, mangoes, chikoo, and some other vegetables are pollinated and dispersed by the fruit bats. Durians and Petai are currently relying only on fruit bat

pollination (Fujita and Tuttle 1991 [8]; Kasso and Balakrishnan 2013) [13] which shows the important of fruit bats in agro-ecosystem rather considering them as fruit pests. The tussle between *Pteropus giganteus* and fruit growers due to crop damages over the past few decades (Roberts 1997 [22]; Walker and Molur 2003) [29] [29] made the species at risk and these disturbances causes the species in stress and lead to several viral outbreaks. The diet of Indian flying fox is not extensively studied in many district of Gujarat. Therefore present work is planned to fill up the empty space in the research area.

### Materials and methods

This study was carried out in two taluka namely Ghogha and Bhavnagar, Bhavnagar district, Gujarat during March 2021 to February 2022. In Ghogha taluka 4 roosting site and Bhavnagar 5 roosting site studied. The diet of *Pteropus giganteus* was analyse by collecting the leftover fruits leaves and other food particles found under the roost site of *Pteropus giganteus* (Sudhakaran and Doss, 2012 [24]). *Pteropus giganteus* reported to swallow ripe and soft fruit or extract juice and spit out the remains known as 'Bolus' (Goveast *et al.* 2006) [9]. The bolus and guano of *Pteropus giganteus* were sampled further analysis. The fresh sample was collected by placing the paper/ plastic sheet on the floor of diurnal roost site (Hodgkin *et al.* 2003) and also an intensive search was made directly under each roost site for a period of 90 minutes to collect the food residues were periodically collected in zip- lock plastic bag and transfer to the laboratory for the further analysis.

**Table 1:** Details of plant species which used as food sources by *Pteropus giganteus* in the study site.

Sr. no	Plant Species name	Family	Part of plant used as food
1	<i>Musa paradisiaca</i>	Musaceae	Ripe fruit and Nectar
2	<i>Anona reticulata</i>	Annonaceae	Ripe fruit
3	<i>Bombax ceiba</i>	Bombacaceae	Flower
4	<i>Carica papaya</i>	Caricaceae	Ripe fruit and flower
5	<i>Terminalia catappa</i>	Combretaceae	Ripe fruit
6	<i>Coccinia grandis</i>	Cucurbitaceae	Ripe fruit
7	<i>Momordica charantia</i>	Cucurbitaceae	Ripe fruit
8	<i>Tamarindus indica</i>	Fabaceae	Ripe fruit and leaves
9	<i>Ficus benghalensis</i>	Moraceae	Ripe Fruit
10	<i>Ficus recemosa</i>	Moraceae	Ripe Fruit
11	<i>ficus religiosa</i>	Moraceae	Ripe fruit
12	<i>Eucalyptus tereticornis</i>	Myrtaceae	Tender And Leaves
13	<i>Psidium guajava</i>	Myrtaceae	Ripe fruit and unripe fruit
14	<i>Syzygium cumini</i>	Myrtaceae	Ripe fruit
15	<i>Zizipus mauritiana</i>	Rhamnaceae	Ripe fruit
16	<i>Manilkara zapota</i>	Sapotaceae	Ripe fruit
17	<i>Azadiracta indica</i>	Meliaceae	Ripe fruit
18	<i>Mangnifera indica</i>	Anacardiaceae	Ripe fruit and leaves
19	<i>Morus nigra</i>	Moraceae	Ripe fruit
20	<i>Ricinus communis</i>	Euphorbiaceae	leaves
21	<i>Punica granatas</i>	lythraceae	Ripe fruits
22	<i>Albizia lebeck</i>	Fabeceae	leaves
23	<i>Manilkara hexandra</i>	Sapotaceae	Ripe fruits
24	<i>Monnon longifolium</i>	Annonaceae	Ripe fruits
25	<i>Pongamia pinnata</i>	Fabaceae	Unripe fruits
26	<i>Ficus carica</i>	Moraceae	Ripe fruits
27	<i>Ficus tsjahela</i>	Moraceae	Ripe fruits
28	<i>Cordia sinensis</i>	Boraginaceae	Ripe fruits

The fecal samples were analysed separately after rehydrated. The collected remnants including seed, fruits and leaves were isolated and identified taxonomically. The majority of the seeds were identified through visual observation by using a hand lance and validation was done using reference (Hodgkison *et al.*, 2003)<sup>[11]</sup>.

**Table 2:** Number of plant species used by *Pteropus giganteus* in various study site.

Sr. no	Roost site	Taluka	No. of plant species
1	Malanka	Bhavnagar	19
2	Koliyak		20
3	Sir P. P. Institute of Science		17
4	Lakhanaka		22
5	Railway colony		12
6	Kukad	Ghogha	23
7	Bhakhhal		19
8	Padva		22
9	Ukharla		14

The separated plant materials were confirmed with help of the expertise in botany department, Sir P. P. Institute of Science, Bhavnagar and Botany department, Sheth L.H. Science College, Mansa, Gandhinagar. Seeds that could not identified visually were germinated and identified. The phenology of fruits and flower preferred by *Pteropus giganteus* in the study sites were observed and the seasonal accessibility was also recorded. Food preference of *Pteropus giganteus* in various stages of development namely ripe and unripe were also recorded. Information of the plant species, belong to which family, the nativity of plant species along with habits and which part is eaten as a food also recorded.



**Plate 1:** Adult male *Pteropus giganteus* Feeding Manilkara zapota fruit



**Plate 2:** Adult *Pteropus giganteus* searching Fruit on ficus benghalensis plant



**Plate 3:** Ejected bolus under roost site.



**Plate 4:** Leftover fruit and seeds under the roost site.

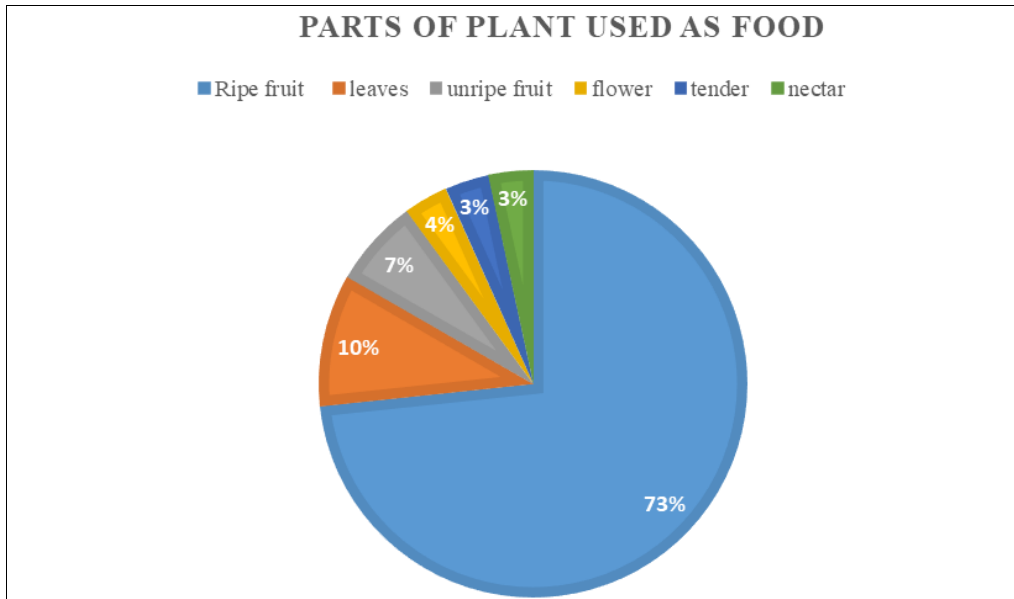
**Result**

Five roost site namely Malanka, Koliyak, Sir P. P. institute of science, Lakhanka and Railway colony in Bhavnagar taluka and four colony namely Kukad, Bhakhal, Padva, Ukharla in Ghogha taluka, Bhavnagar district was selected intensive sites to find out the diet and diet use of *Pteropus giganteus* shown in Table 1. Total 28 plant species belonging to 16 family was used by *Pteropus giganteus*. It was observed that Kukad study site of Ghogha taluka provides the maximum number of food plants (23) followed by Padva and Lakhanka roost site with 22 species while Railway colony and Ukharla roost site Provides minimum

Number of food plant, with 12 and 14 species respectively. (Table 2).

Among the plant species *Ficus benghalensis*, *ficus racemosa* and *Manilkara Zapota* were massively used by the *Pteropus giganteus* followed by *Ficus tsjahela*, *Terminalia catappa* and *Azadirachta Indica*. Plant species namely *Manilkara hexandra*, *Ziziphus Mauritania*, *Monnon longifolium*, *Cordia sinensis*, and *Psidium Guajava* were used less in the study area.

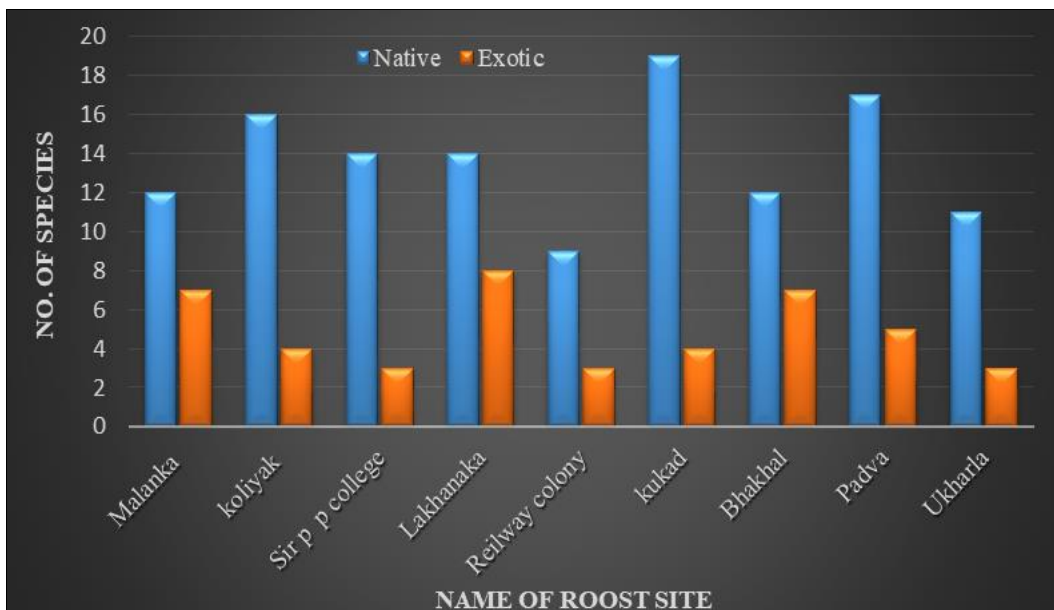
Various stage of fruit/ part of plant eaten as food by *Pteropus giganteus* were collected (Figure 1). Data shows that *Pteropus giganteus* preferred the ripe fruit (73%) rather than leaves and unripe fruit.



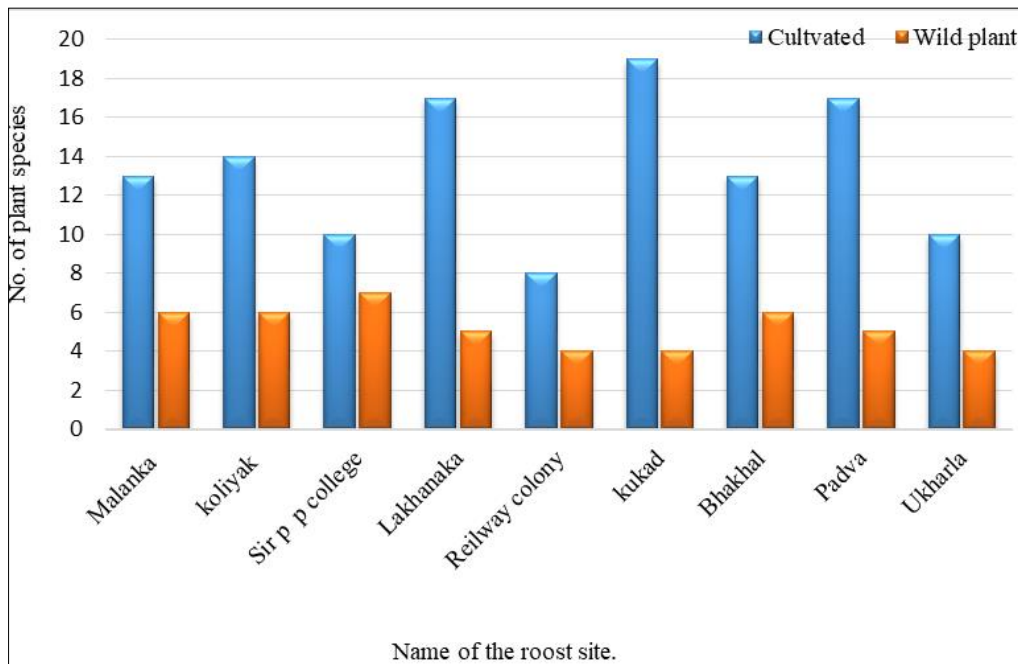
**Fig 1:** Diet of *Pteropus giganteus* based on the parts of pant used as food.

Nativity of plant species used by *Pteropus giganteus* was also assessed and found that they use more native food plant as their major source of diet than exotic species (Figure 2). The food plant use as diet by *Pteropus giganteus* was assessed on based of the plant habit (climber, herbs and

trees). It was recorded that large trees were preferred as food (53%) by *Pteropus giganteus* followed by herb and climber. Data shows that *Pteropus giganteus* mostly consumed more food from the cultivated plants other than the wild plant (Figure 3).



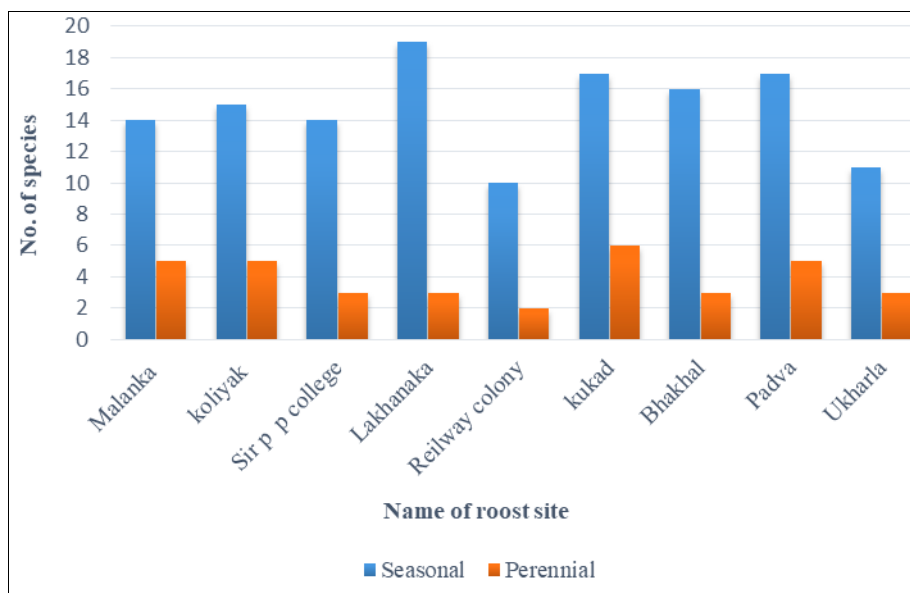
**Fig 2:** Diet of *Pteropus giganteus* based on the nativity of plant sp.



**Fig 3:** Diet of *Pteropus giganteus* based on the plant regeneration.

Diet of *Pteropus giganteus* based on the phenology of plant were also recorded and the result showed that they use more seasonal plant species (flowering and fruiting only in

specific seasons) than the perennial species (flowering and fruiting throughout the year) (Fig.4)



**Fig 4:** Diet of *Pteropus giganteus* based on tree species regeneration.

**Discussion**

Bats are nocturnal mammals remain active at night and known to forage in different modes based on divers food items like insects, nectar, fruits, seeds, small bird and mammals and also blood (Kunz *et al.* 2011).<sup>[14]</sup> Attempt was made to study the diet and diet use of *Pteropus giganteus* in the present study and the result obtained in the present study is comparable with other studies done in Indian subcontinent (Gulraiz *et al.*, 2016<sup>[10]</sup>; Javid *et al.*, 2017)<sup>[12]</sup>. Javid *et al* (2017)<sup>[12]</sup> recorded a total 32 number of plant species belonging to 23 genera and 15 family from the eject sample of fruit bats from Pakistan. Of these 8 of plant species was domestic and the remaining 24 was exotic, 13 species were commercially important, while 19 species

had no commercial value. Similarly Gulraiz *et al* (2016)<sup>[10]</sup> reported that the use of 170 plant seed belonging to 12 species and 11 genera and 6 family as the diet of *Pteropus giganteus* in Pakistan. The result of present study finds some similarity with previous studies reported in another place of India.

Although there are no specific studies on the annual diet source of *Pteropus giganteus* in India few scattered report mentioned that *ficus benghalensis*, *Azadirachta indica*, *magnifera indica*, *Psidium guajava* have been widely used by *Pteropus giganteus* (Roberts, 1997<sup>[22]</sup>; Chakraverthy and Girinis, 2003)<sup>[4]</sup>. A study on the diet selection of *Pteropus giganteus* was done using the ejected pellets, dropped fruits, fecal sample and seed from Madurai regions, Tamilnadu

(Vedan and Kaleeswaran, 2011). In the study 21 plant species used as food plant by *Pteropus giganteus*. Sudhakaran and Doss (2012) [24] reported the diet and foraging behaviour of three Pteropodids bats in Tirunelveli and Tuticorin area of Tamilnadu. They identified a total 37 plant species as food plant of Pteropodids bats. The preference of fruit by Pteropodids varied as per to the developmental stages of fruit like immature, unripe and ripe. Prasad *et al.* (2014) [20] recorded total 22 plant seed from ejected bolus, chewed fruits and fecal materials from the roosting site of the *Pteropus giganteus* in Kerala. The diet of *Pteropus giganteus* recorded during the study is comparable with earlier reports. In the present study it could be concluded that the *Pteropus giganteus* consume wide varieties of fruit plant species and play a vital role in the seed dispersal of fruit crop having commercial values and demand in the market (Prasad *et al.* 2014) [20]. Hence, the *Pteropus giganteus* could be considered as a vital mammal species for pollination (Sudhakaran and Doss, 2012) [24].

A number of factor could influence on foraging behaviour of *Pteropus giganteus* including energy needs, requirement for specific nutrient, reproductive status and constraints of digestive system, abundance, diversity, seasonality of different food items, competition with other species, and predation (Fleming, 1988) [6]. Only a few studied have investigated as to how and when the bats utilize these resource. The conflict between bats and orchard owner due to crop damage over the past few decades (Roberts, 1997 [22]; Walker and Molur 2003) made the species at risk and the influence of climate change in changing, pattern of invasive proliferation in their habitats also made the species at high risk. Investigation related to ecological value and ecosystem services of *Pteropus giganteus* are warranted to initiate the better conservation measures. Loss of habitat, degradation, and alteration are having negative impact on bats, as these anthropogenic pressure reduce the availability of suitable roosting sites which ultimately reduce bats population and survival rate, which also leads to the several outbreaks. The local public awareness on the importance of bats in pollination, seed dispersal and other benefits may help to preserve their roosting habitat (Fleming *et al.*, 1987 [7]; Corbett 1998, Agoramoorthy and Hsu, 2005) [1].

Despite beneficial role of *Pteropus giganteus* have been hunt down as source of protein and medicinal uses and considered as fruit eating pests. They are the most mistaken species in India and are registered on schedule II. The IUCN red list of threatened species has classified this species as least concerned now there is need to change the current status of *Pteropus giganteus* in India. It was possible that when the wildlife protection act was formulated (1972) there was a lack of adequate scientific evidence about the ecological and beneficial roles of *Pteropus giganteus* where the ecological research was in infancy.

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