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Food habits of African elephant (*Loxodonta africana*) in Babile Elephant Sanctuary, Ethiopia

YIHEW BIRU[1] & AFEWORK BEKELE[2*]

[1]*Department of Life Sciences, Dire Dawa University, P.O. Box 1362, Dire Dawa, Ethiopia*
[2]*Department of Biology, Addis Ababa University, P.O. Box 1176, Addis Ababa, Ethiopia*

Abstract: Seasonal dietary composition and food habits of the African elephant (*Loxodonta africana*) were studied in Babile Elephant Sanctuary, Ethiopia. Both focal watch and indirect methods such as analyzing habitat, interviews, and identifying seeds in the dung were used to collect data. Food habit was quantified by calculating preference indices. Elephants consumed 73 plant species. Data on fresh feeding signs either browsed or debarked showed 51 species, while an examination of elephant dung piles yielded seeds representing 21 species. Among the plants consumed by elephants, *Opuntia ficus-indica* was utilized the most (23.81 %), followed by *Acacia robusta* (20.17 %), *Acacia nigrii* (12.61 %) and *Opuntia stricta* (10.20 %). All other recorded plants were utilized below 10 %. This is a relict population of African elephant, which is in danger of extinction due to habitat loss and degradation.

Resumen: La composición estacional de la dieta y los hábitos alimenticios del elefante africano (*Loxodonta africana*) fueron estudiados en el Santuario para Elefantes Babile, Etiopía. Los datos se obtuvieron a partir de observaciones directas y de métodos indirectos tales como el análisis del hábitat, entrevistas y la identificación de semillas en el estiércol. El hábito alimenticio fue cuantificado por medio del cálculo de índices de preferencia. Los elefantes consumieron 73 especies de plantas. Los datos de los signos de alimentación reciente, incluyendo ramoneo y descortezamiento, revelaron 51 especies, mientras que la revisión de montones de estiércol de elefante produjo semillas que representaron 21 especies. Entre las plantas consumidas por los elefantes, *Opuntia ficus-indica* fue la más utilizada (23.81 %), seguida por *Acacia robusta* (20.17 %), *Acacia nigrii* (12.61 %) y *Opuntia stricta* (10.20 %). Todas las otras plantas registradas fueron utilizadas por debajo del 10 %. Ésta es una población relictual de elefante africano, en peligro de extinción debido a la degradación y pérdida de hábitat.

Resumo: A composição da dieta sazonal e hábitos alimentares do elefante Africano (*Loxodonta africana*) foram estudados em Babile Elephant Sanctuary, na Etiópia. Para a colecta de dados usaram-se quer a observação directa, quer os métodos indirectos como a análise do habitat, entrevistas e identificação de sementes nas fezes. Os hábitos alimentares foram quantificados pelo cálculo dos índices de preferência. Os elefantes consumiram 73 espécies de plantas. Os dados sobre os sinais de alimentação fresca,quer de folhas quer descascada,mostrou 51 espécies, enquanto um exame de pilhas de dejectos de elefante mostraram a presença de sementes representando 21 espécies. Entre as plantas consumidas pelos elefantes, a *Opuntia ficus-indica* foi maioritariamente utilizada (23,81 %), seguida pela *Acacia robusta* (20,17 %), *Acacia nigrii* (12,61 %) e *Opuntia stricta* (10,20 %). Todas as outras plantas registadas, foram utilizadas abaixo de 10 %. Esta é uma população relicta de elefante Africano, em perigo de extinção devido à perda e degradação dos habitats.

* *Corresponding Author*; e-mail: afeworkbekele@hotmail.com; asse.biru@gmail.com

Key words: Browse, dietary composition, dung pile, elephant, food preferences.

Introduction

The survival of African as well as Asian elephants largely depends upon availability of extensive habitats free from human habitations and adequate protection. However, their populations have declined in many regions due to drought, excessive anthropogenic pressures resulting in habitat loss, desertification, and poaching for ivory (Areendran *et al.* 2011; Feldhamer *et al.* 2007; Hoare & Du Toit 1999). In arid and semi-arid areas, African elephants (*Loxodonta africana*), compete with people, as their small protected areas are inadequate to meet their life requisites and often they end up with conflicts with people (Roux 2006). Elephants play an important ecological role in savannah and forest ecosystems by maintaining suitable habitats for numerous species (Stephenson 2007). As explained by Dudley (2000), the functional niche of elephants is unique in terms of the high 'catholic diet' and the spatial extent of the effective foraging zone as an umbrella species.

The African elephants, the largest living terrestrial mammal (Feldhamer *et al.* 2007), are generalist herbivores relying on widely distributed resources (Archie *et al.* 2006; Osborn 2005; Wittemyer *et al.* 2007). Their food items include bark, fruits, leaves and stems, flowers and fruits depending upon availability (Feldhamer *et al.* 2007; Rode *et al.* 2006). Being megaherbivores, elephants need to take sufficient amount of forage and water per day (Guy 1976; Jackson & Erasmus 2005; Stephenson 2007; Wyatt & Eltringham 1974). To satisfy this nutritional demand, they usually require large home ranges (Galanti *et al.* 2006; Jackson & Erasmus 2005; Whitehouse & Schoeman 2003). However, the ever increasing human population all over the world has increased conflicts between elephants and humans for resources and poses major challenge for conservation agencies (Afolayan 1975). Although, African elephant is a generalist herbivore (Wittemyer *et al.* 2007), very little information is available on their diet composition and feeding habits in and around Babile Elephant Sanctuary (BES). The food abundance as well as home range of the elephants in this sanctuary has undergone major changes due to habitat alteration by biofuel producing company. In addition, the habitat of elephants in this area is affected by deforestation, agriculture, settlement, charcoal production and overgrazing (Belayneh 2006; Demeke 2008; Hillman 1993; Wodu 2007). Information on the food preference and availability of such plant species will help conservationists to design a suitable plan for the restoration of habitat and elephant population.

Materials and methods

Study area

The Babile Elephant Sanctuary (BES) is situated at the semi-arid trans-boundary between the Oromiya (22.3 %) and Somali (77.7 %) regions of Ethiopia, about 560 km southeast of Addis Ababa (Demeke 2008). It is situated between latitudes 08° 22' 30" - 09° 00' 30" N and longitudes 42° 01' 10" - 43° 05' 50" E (Fig. 1). The elevation ranges from 850 to 1785 m asl. The area is drained by Daketa, Borale and Erer Rivers. This sanctuary (6,982 km^2) is established to conserve the only known isolated and ecologically distinct population of elephants (Barnes *et al.* 1999; Hillman 1993). As reported by Demeke (2008), an estimated number of 264 elephants occurred in the study area. However, anthropogenic pressures and extraction of biomass have led to degradation of the habitat. Woody plants in the area are used in varying degrees by the local communities. Ethno-medicinal harvest takes the largest share followed by collection of wood for fence and fire wood as well as charcoal production and construction (Wodu 2007). There is also a high degree of competition for food between elephants and large herds of cattle and camels in the area (Belayneh 2006; Demeke 2008). The rural part of Babile district contains a human population of 75,970 (38,371 males and 37,599 females) (FDREPCC 2008). The study area lies in the semi-arid region. Mean monthly minimum and maximum temperatures recorded were 13.0 °C and 26.3 °C, respectively. The mean annual rainfall is 517.2 mm, with high variation from year to year, ranging from 451.7 mm to 1,275.5 mm. The vegetation of the Sanctuary is represented by *Acacia commiphora* woodland, desert and semi desert scrubland and evergreen scrub (Belayneh 2006; White 1983). The area is also known for its diverse groups of animals that are well adapted for arid and semi-arid environment. Crested porcupine (*Hystrix*

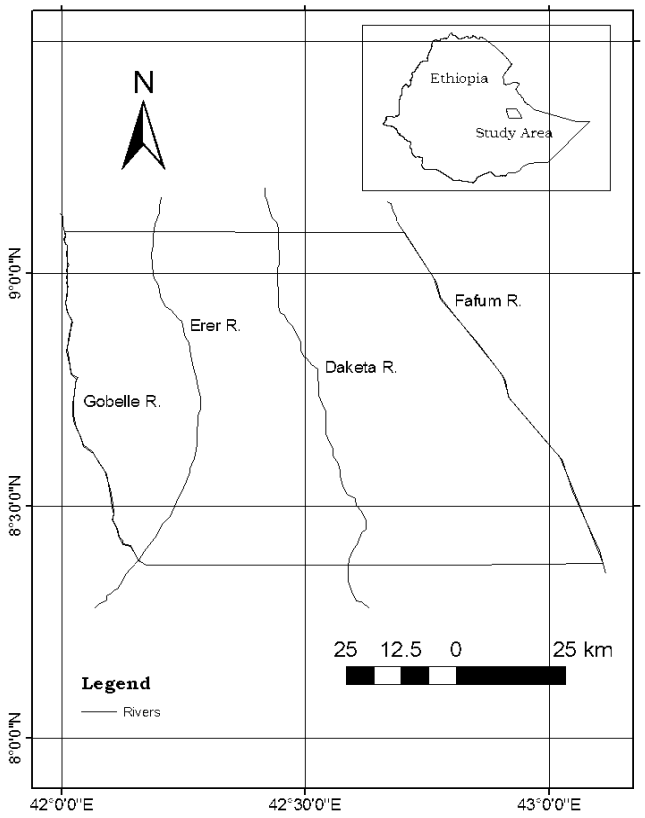

Fig. 1. Location map of Babile Elephant Sanctuary.

cristata), Abyssinian hare (*Lepus habessinicus*), Grivet monkey (*Cercopithecus aethiops*), Hamadryas baboon (*Papio hamadryas*) and Lesser galago (*Galago senegalensis*), Black-backed jackal (*Canis mesomelas*), White-tailed mongoose (*Ichneumia albicauda*), Dwarf mongoose (*Helogale parvula*), Spotted hyaena (*Crocuta crocuta*), Large-spotted genet (*Genetta macullata*), Caracal (*Lynx caracal*), Lion (*Panthera leo*), Leopard (*Panthera parduus*), Rock hyrax (*Procavia capensis*), Elephants, Warthogs (*Phacochoerus africanus* and *P. aethiopicus*), Bushbuck (*Tragelaphus scriptus*), Lesser and Grater kudus (*Tragelaphus imberbis* and *T. strepsiceros*), Bush duiker (*Sylvicapra grimmia*), Phillip's dik-dik (*Madaqua saltiana*) and Guenther's dik-dik (*Rhynchotragus guentheri*) are found in the sanctuary. Four species of rodents and seven species of bats have also been recorded. The Sanctuary is also among the important bird areas in the country (EWNHS 1996).

Methods

The food habits of elephants were studied by focal scanning of targeted individuals during their feeding activity (Milewski & Madden 2006), indirectly by interviewing wildlife scouts and local residents, and identifying seeds in the dung (Morgan 2007). Sampling of partly used food plants by elephants such as chewed vegetation, browsed branches, debarked trees and scratched posts were also carried out (Chen *et al.* 2006; Demeke & Bekele 2000; Shoshani *et al.* 2004; White 1994). A reconnaissance survey was carried out during the first week of August 2008 to identify suitable sampling sites in the study area. Twelve sample blocks were located along elephant paths. Seventy four quadrats were established systematically within the blocks each having size of (20 m x 20 m) for vegetation study in the Upper Erer Valley. The studied plots were immediately examined after the herd left for another location. In each plot number of food plants and part(s) eaten were recorded. For each species, presence or absence of feeding sign was recorded but it was not possible to quantify the amount consumed (Santra *et al.* 2008). For woody species, the diameter at breast height (dbh) was measured and recorded. Plant samples were preserved in plant press for identification following standard procedures (Bridson & Forman 1992) and for confirmation from the National Herbarium, Addis Ababa University. To assess the seeds of plant species in the elephant dung, fresh to nearly fresh boli at 5 m interval were collected to avoid collection of dung from same accumulation (Yumoto *et al.* 1995). Dung collection was carried out following Dudley (2000) using plot samples and opportunistic site sampling techniques. A collected bolus was then dissected by hand to identify and count the number of intact and undamaged seeds of each species (Gonthier 2007; Stewart 1967). The fruit fragments were also studied to get additional information on dietary habits.

Data on food preference was gathered during the wet season (August to November 2008) and dry season (December 2008 to March 2009).

Data analysis

Diet composition was analyzed by identifying the different species of plants consumed by elephants, computing their relative frequency in the diet, their relative abundance in the study area and thereby calculating preference indices. Preference was quantified by calculating preference indices for the species in the diet. Preference index was calculated by dividing percentage utilization by the percentage availability in the environment (De Boer *et al.* 2000; Fritz *et al.* 1996; Kassa *et al.*

Table 1. Cultivated plants consumed by elephants (local names are in Oromifa language).

Scientific name	Local name	Family	Part Consumed
Annona cherimola	Gishta	Annonaceae	Leaves and fruits
Arachis hypogea	Lewiz	-	Pod and leaves
Carica papaya	Papaye	Caricaceae	Leaves and fruits
Casimiroa edulis	Ambuka	Rutaceae	Leaves and fruits
Cucurbita pepo	Duba	Cucurbitaceae	Leaves, stems and fresh fruits
Ipomoea batatas	Mitatis	Convolvulaceae	Leaves, stems and tubers
Lagenaria siceraria	Buqqe	Cucurbitaceae	Leaves and stems
Lycopersicon esculentum	Timatime	Solanaceae	Leaves and fruits
Mangifera indica	Amba	Anacardiaceae	Leaves, bark and fruits
Musa paradisiaca	Muza	Musaceae	Leaves and fruits
Psidium guajava	Zeyituna	Myrtaceae	Leaves, bark and fruits
Saccharum officinarum	Alla	Poaceae	Leaves and stems
Sorghum bicolor	Bishinga	Poaceae	Leaves, stems and seeds
Zea mays	Boqollo	Poaceae	Leaves, stems and seeds

2007; Parker *et al.* 2003; Roux 2006; Uresk 1984) using the following formula:

$$\text{Food Preference (PI)} = \frac{\text{Percentage Utilization}}{\text{Percentage Availability in the environment}}$$

where, percentage utilization is the percentage of a given plant consumed as food and is a ratio of species in the diet to all species consumed, while availability in the environment is a ratio of the total number of individuals of a single species to the total number of individuals of all species observed in all the observation blocks. Dietary composition and food preferences were used to identify those plant species that are essential for sustainability of elephants.

Tree density, frequency, dbh and basal area were used to explain species availability in the study area. Data collected on seasonal dietary composition and preference was coded and analyzed using SPSS Version 16. Chi-square test of relative percentage frequency was performed to identify the significant food in the diet, whereas the non-parametric Mann Whitney U-test was used to test the significance of season on the diet of elephants.

Results

Elephants in BES were observed to feed on 59 plants in the wild belonging to 30 families. In addition, 14 species of cultivated plants of 10 families were consumed (Tables 1 & 2). Wild food plants included 28 species of shrubs, 24 species of trees, 5 species herbs and 2 species of grasses. Visual estimation of dung analysis revealed the occurrence of more grass fragments during the wet season compared to dry season. Elephants were observed to feed relatively more on diverse food sources during the wet season (65 %) than during the dry season (35 %) (Table 3). *Acacia nigrii, Acacia robusta, Acacia brevispica, Opuntia ficus-indica* and *Opuntia stricta* were the most abundant species in terms of elephant food resources available in BES, while *Acacia albida* and *Acacia seyal* were the least encountered species. Among all the species consumed, *O. ficus-indica* (23.81 %), *A. robusta* (20.17 %), *A. nigrii* (12.61 %), *O. stricta* (10.20 %) and *A. brevispica* (8.81 %) were the most utilized species by elephants (Table 2). Elephants were observed feeding on growing shoots, leaves and fruits during the wet season while taking barks and whatever available during the dry season.

Elephants showed a selective preference for 22 out of the 35 most important species in the diet as determined by field observation (Table 2) which is percentage availability based on individual observation and calculated only for the consumed species. The strongest preferences were for *A. albida, A. seyal, A. robusta* and *O. ficus-indica*. Elephants exhibited a selective avoidance for *Combretum molle* and *Grewia flavescens*. Results from direct observations and dung analysis showed that there was no significant difference among the species consumed across seasons (Mann Whitney = 0.121, df = 1, $P > 0.05$). *O. ficus-indica* was primarily brow-

Table 2. Preference indices (PI) for the most important species in the diet of elephants (% in diet = percentage of a species in the diet, % in field = percentage occurrence of a species in the field, P = preference, + = preference of species, - = avoidance).

Species	% in diet	% in field	PI	P
Acacia albida	0.03	0.01	3.1747	+
Acacia seyal	0.03	0.01	3.1747	+
Trichilia emettca	0.26	0.10	2.5397	+
Acacia nilotica	0.23	0.09	2.4692	+
Opuntia ficus-indica	23.81	11.61	2.0502	+
Carissa spinarum	0.23	0.12	1.8519	+
Acokanthera schimperi	0.29	0.16	1.7857	+
Grewia bicolor	2.35	1.34	1.7557	+
Grewia villosa	1.99	1.22	1.6402	+
Chionothrix latifolia	0.03	0.02	1.5873	+
Dobera glabra	0.10	0.06	1.5873	+
Ochna inermis	3.60	2.53	1.4222	+
Grewia erythraea	1.74	1.23	1.4168	+
Acacia robusta	20.17	15.43	1.3070	+
Euclea schimperi	0.23	0.17	1.3072	+
Dichrostachyus cinerea	2.03	1.58	1.2821	+
Berchemia discolor	0.29	0.23	1.2423	+
Acacia bussei	1.51	1.25	1.2131	+
Acacia oerfota	0.48	0.42	1.1615	+
Asparagus leptocladodius	0.03	0.03	1.0582	+
Balanites aegyptiaca	2.57	2.48	1.0366	+
Capparis tomentosa	0.19	0.19	1.0025	+
Acacia mellifera	2.09	2.14	0.9780	-
Cadaba farinosa	0.42	0.47	0.8972	-
Kleinia squarrosa	0.58	0.71	0.8163	-
Acacia brevispica	8.81	10.88	0.8099	-
Grewia schweinfurthii	0.06	0.08	0.7937	-
Opuntia stricta	10.20	13.07	0.7801	-
Ziziphus spina-christi	0.29	0.39	0.7519	-
Acacia tortilis	2.73	3.73	0.7333	-
Balanites glabra	1.42	1.98	0.7163	-
Acacia nigrii	12.61	17.68	0.7132	-
Aloe pirottae	0.26	0.52	0.4980	-
Grewia flavescens	2.25	9.24	0.2437	-
Combretum molle	0.10	0.69	0.1401	-

sed during the wet season (26.3 %) (χ^2 = 19.1, df = 35, P < 0.001) while *A. robusta* was the major component of the diet during the dry season (23.9 %) (χ^2 = 14.7, df = 35, P < 0.001). The majority of *Acacia* species were browsed more during the dry season than the wet season (Fig. 2).

A total of 71 dung boli were dissected, yielding 3442 seeds of 21 different plant species (Table 3). The average number of woody plant seeds per bolus was 48.23 (Table 3). *O. ficus-indica, Dichrostachyus cinerea, Acacia oerfota* and *Grewia erythraea* had the highest frequencies of seeds in the dung

Table 3. Seasonal seed composition of elephant dung and mean seed per dung bolus obtained from dung analysis (SFWS: seeds found during the wet season, SFDS: seeds found during the dry season, MSDB: seed per dung bolus).

Species	SFWS	SFDS	Total	% in dung	MSDB
Acacia oerfota	317	121	438	12.73	6.17
Acacia tortilis	21	12	33	0.96	0.465
Acacia robusta	73	13	86	2.50	1.211
Balanites aegyptiaca	-	3	3	0.09	0.042
Berchemia discolor	51	11	63	1.83	0.887
Dichrostachyus cinerea	597	249	846	24.58	11.92
Grewia bicolor	53	28	81	2.35	1.141
Grewia erythraea	296	131	427	12.41	6.01
Grewia flavescens	-	27	27	0.78	0.38
Dichrostachyus schweinfurthii	11	-	11	0.32	0.155
Grewia villosa	46	16	62	1.80	0.873
Lantara camara	201	153	354	10.28	4.99
Commiphora schimperi	-	3	3	0.09	0.042
Opuntia ficus-indica	622	289	911	26.47	12.83
Tamarindus indica	1	3	4	0.12	0.056
Terminalia brownie	4	-	4	0.12	0.056
Trichlia emettca	1	6	7	0.20	0.099
Ziziphus spina-christi	-	7	7	0.20	0.099
Cryptostegia grandiflora	15	3	18	0.52	0.254
Unknown 1	34	-	34	0.99	0.479
Unknown 2	9	14	23	0.67	0.007
Total	2352	1090	3442	100	48.2

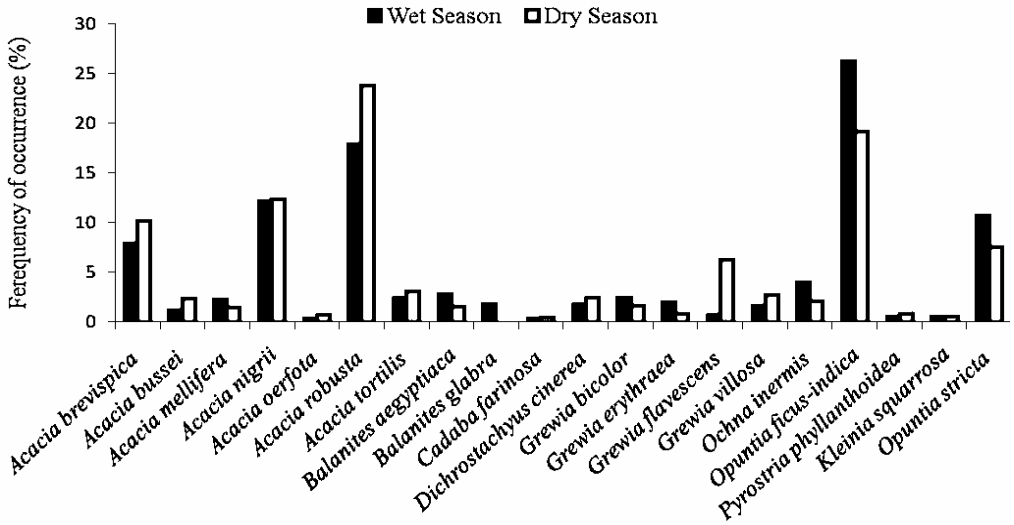

Fig. 2. Browsed plants by elephants based upon seasons.

(>10 %). *A. robusta* and *Grewia bicolor* were also found to have greater than one seed per bolus. Twenty species were observed fruiting during the study period, of which 13 were present in the elephant dung. Adult trees of all the seed species found in the elephant dung were observed in the study area with the exception of the unidentified seeds. *Lantana camara, Commiphora schimperi, Tamarindus indica, Terminalia brownie, Cryptostegia grandiflora* were exclusively identified in the dung survey that were missed in the diet observation.

Discussion

Elephant diet has been the focus of much research in Africa. Previous studies have indicated that elephants feed on a diverse array of plant species, i.e., as many as 120 different species (De Boer *et al.* 2000; Guy 1976). The results of the present study confirmed 73 species consumed by elephants. Lower number of species consumed in the present study might be due to the human impact on the habitat (Belayneh 2006; Wodu 2007), limited diversity of the species in the area and widespread settlement which is strongly affecting the movement pattern and home range of the elephants.

A number of previous studies have highlighted seasonal changes in the presence of grass in the diet of elephants during the wet and dry seasons (Osborn 2004; Wyatt & Eltringham 1974; Williamson 1975) but, this varied between localities and may vary with the plant species (Westoby 1978). For example, elephant diets in Hwange National Park, Zimbabwe, appeared to consist almost entirely of woody plants (Williamson 1975). In Maputo Elephant Reserve, browse is more important than grass during both wet and dry seasons (De Boer *et al.* 2000). Browse comprised the majority of the diet of elephants both during the wet and dry seasons in the present study and a similar result was reported for elephants in Chebera Churchura National Park, western Ethiopia (Admasu 2006). This change in food preferences of elephants probably is linked with both human and habitat factors. Absence of large grassland habitat in BES can also have impact on food selection and proportion of browse in the diet of elephants during both seasons. The presence of characteristic pioneer species during the dry season such as *Dichrostachys cinerea, Capparis* species and *Carissa spinarum* (Fernando *et al.* 2008) in addition to *Acacia* species that provide food, lead to the absence of significant seasonal variation in dietary composition in the present study area.

Elephants showed a strong preference for *A. robusta* and *O. ficus-indica* while *C. molle* and *G. flavescens* were selectively avoided. Of the observed food plants, *Acacia* species were highly utilized during the study period. This may be due to the wide distribution of *Acacia* species in many parts of the Sanctuary (Belayneh 2006; Wodu 2007), as elephants used to utilize species based on their availability (Mwalyosi 1990). It can also be associated with palatability of *Acacia* species during both seasons (Caister *et al.* 2003) or may be due to the high crude protein content, low fibre and high water content of the species (Calenge *et al.* 2002; Parker *et al.* 2003; Sauer *et al.* 1977). The high preference index value of *A. albida* and *A. seyal* might be due to the rare occurrence in the area or were undercounted during vegetation study in the diet and removed from preference index analysis in order to avoid confusion with the abundant species. However, de Garine-Wichatitsky *et al.* (2004) and Milewski & Madden (2006) found that *A. seyal* was preferentially browsed by large browsers like giraffe, eland, impala and greater kudu, which supports the present result. Again, previous studies by Belayneh (2006) and Wodu (2007) in BES also indicated the impact of preferential utilization of elephants on *A. albida* and *A. seyal* resulting in a high rate of decline of these species in the Sanctuary, which is an indication of selective preference for the two species.

Among *Acacia* species, elephants showed both preference and avoidance for individual species. However, a selective avoidance does not necessarily mean a species is avoided completely (Parker 2004). A species could be an important component of the diet and still has a negative preference value. For example, *A. brevispica* and *A. nigrii* had relatively a close frequency of occurrence in the diet (8.8 and 12.6 %, respectively), but *A. nigrii* was more abundant in magnitude than *A. brevispica* in all study blocks. Thus, while both are important in the diet, *A. brevispica* was relatively preferred, while *A. nigrii* was used less than available (Roux 2006) and it is likely that elephants will have a negative effect on *A. brevispica* than on *A. nigrii*. The high preference of *O. ficus-indica* may be due to the succulence and low fibre content favouring digestibility and retention of fleshy green leaves during the dry season (Mukinya 1973). In the present study, elephants were observed staying 3-4 days in cactus fields without visiting water sources, which may be due to the high water content of the cactus. Relative preference of *O. ficus-indica* during the wet season can be associated with fruiting of the species during this period. *O. ficus-indica* is also consumed by humans and is a source of income in local markets. There is competition for the fruit of this species between elephants and humans in addition to the high density of livestock looking for it.

Although elephants are generalist herbivores, they were observed selecting food that offers the highest rate of nutrient intake at any given place or time (Osborn 2004). Accordingly, selective utili-

zation of *A. albida, A. seyal, A. nilotica, A. brevispica, B. minimifolia* and *E. burana* by elephants coupled with habitat degradation can have strong effect on their regeneration. For example, all the observed individuals of *A. brevispica* were small seedlings and saplings, which are still exposed to small browsers, livestock and fire in the area. Fire has an effect in preventing regeneration and seedling growth (Laws 1970; Mapaure & Campbell 2002). Even though it is not encountered during the present diet study, according to information from the local people and wildlife scouts, the most preferred food item of elephants, *E. burana*, is at present difficult to find in any part of the Sanctuary.

In addition to wild species, 14 cultivated crops and vegetables were recorded as consumed by elephants in the present study area. Among these, sorghum, maize, mango, papaya, pumpkin, sweet potato and ground nut were the most preferred species. Selection of these species may be due to their high nutritional value, palatability, ease of handling during foraging and digestibility (Hamilton *et al.* 2005; Lee & Graham 2006; Osborn 2004).

The result of this study is important for elephant management and conservation of BES as it provides information about the food requirements of elephants. In order to fully understand the relationship between food plants and elephants, further study on nutrient analysis of the most important but threatened species such as *A. albida*, *A. seyal*, *A. nilotica, A. brevispica, B. minimifolia, E. burana* and *Opuntia* species should be carried out. Further study is necessary on the most abundant seeds deposited in the elephant dung to understand the role of elephants in recruitment and distribution of plant species. All the illegal activities carried out in and around the Sanctuary such as farming, charcoal production and logging need a strong attention from both the Federal, Regional and local administrative bodies. The effect of Flora Eco-Power investment activity in or near the BES needs immediate attention and there should be a way to relocate the biofuel project and restoration of the area, as the project is planted in the natural home range of the elephants.

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