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The utilization pattern of wild plant species by migratory elephants in relation to their nutritive values in South West Bengal forests

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Abstract. The study was carried out on the utilization pattern of various wild plant species by migratory elephants in relation to their nutritive values. It was observed that migratory elephants were highly selective for food plants in the wilderness. Only 17 plant species were found to be utilized either fully or partially as evidenced by branch breaking, debarking, uprooting etc. Overall utilization of food plants revealed that *Diospyros melanoxylon* was utilized maximum (34.39%) followed by *Pterocarpus marsupium* (24.86%) among all the recorded plants. Bark of *Buchanania latifolia* was moderately utilized (10.58%). All other recorded plants were utilized below 10 percent. Chemical composition of some wild plants consumed by elephants revealed that crude protein content varied form 3.18 (*Shorea robusta)* to 21.25 (*P. marsupium*) g percent. Crude fibre content ranged from 20.0 (*P. marsupium*) to 54.0 (*D. melanoxylon*) percent. Root of *D. melanoxylon* and bark of *Careya arborea* had higher crude fibre contents. Sodium content of *Terminalia tomentosa* bark was much higher (2.57 mg/g) than that of bark of *Shorea robusta* (0.78 mg/g). Potassium content in recorded plants ranged from 18.76 (*S. robusta*) to 154.83 (*Gardenia gummifera*) mg/g. Calcium content in bark ranged from 7.34 to 32.50 mg/g except in *S. robusta* (1.7 mg/g). Lowest manganese content was found in the fruits of *Aegle mermelos* (0.02 mg/g). Copper content varies from 0.03 (*B. latifolia*) to 1.42 (S. robusta) mg/g. Zinc content ranged from 0.01 to 3.36 mg/g in the studied plants. High protein content of *P.marsupium* leaves is the probable reasons for highest degree of utilization. It was found a positive correlation between degree of debarking by elephants and calcium content of the plant species.

Key words: migratory elephants, wild food plants, chemical composition of food plants

Introduction

Elephants travel a long distance during their seasonal movement and take clear ecological advantages (Sikes 1971). Though they have no seasonally distinct ranges, elephants however move widely to find food patches that are sufficiently rich with habitat resources to support them (Olivier 1978). In South West Bengal elephants were abundant in dense Sal forests (*Shorea robusta*) of Midnapur district and its adjoining areas in early 1900's (O'Malley 1911) and subsequently became rare until 1980's due to loss of forests (Palit 1991; Panda 1996). However since 1987 a group of elephants totalling 40-60 has been migrating from Dalma Wildlife Sanctuary of Jharkhand state to vast areas of South West Bengal forests during August-September and remain for 6-7 months. Over the years, the herds are advancing their date of arrival to South Bengal forests and delaying departure till sal leaves turn yellow and start shedding. Elephants become a subject of great concern in terms of economic loss and loss of human lives in this region. Present situation is also posing many questions about myriad conservation problem for this endangered species in its one of last few strongholds. Most of the forest staff remain engaged in managing the elephant menace but without any fruitful outcome the normal activities of the forest department are hampered during those periods.

During their stay elephants however range over large areas to meet their huge requirements of food, water and shelter and this brings them into greater contact with human settlements. Elephants consume wild plants as well as cultivated agricultural crops. Although elephant's food comprises of a wide variety of plants, the migratory elephants selectively consumes a few wild plant species. The factor that influences the decision to consume or reject a plant is the palatability of the item (Sukumar 1990) and ungulates show a positive selection of plant species and plant parts with the highest protein value (Field 1976) or minerals such as sodium (Belovsky 1981).

The present study was therefore undertaken to understand the utilization pattern of various wild food plant species as part of their feeding strategy in terms of nutritive values.

Materials and Methods

Study area

The study area is located in the districts of West Midnapur, Bankura and Purulia between latitudes 22° 25′ North and longitudes 86° 30′ to 87° 49′ East. The general topography varies from 200 m to 670 m. The soil is mainly red sandy, lateritic and alluvial type with red and black solid in a few pockets (Ghosh 1992). The study area has four major river catchments-Subernrekha, Kangsabati, Silabati and Darkeshwar. The innumerable man-made water bodies and ponds created for the purpose of domestic uses and soil-moisture conservation programme are found in this region. The maximum temperature fluctuates between 42° C and 46° C during summer and in winter it varies from 8° C to 13° C. The monsoon period is from mid-June to end of September. The average rainfall in the study area ranges between 1,180 and 1,428 mm. The forest types in the studied area are Tropical Dry Deciduous dominated by sal (Champion and Seth 1968). Forests are divided into four broad categories: sal coppice, open scrub, open scrub with sporadic sal and plantations. Leopards, sloth bears, wolf, hyaena, wild pig, common langur, fox, wild cat, mongoose, pangolin and various reptiles are found in South West Bengal forests. Besides migratory elephants the area is also having resident elephants.

Data collection

Four plots measuring 1,500 m^2 each were studied in four forests viz. Uthan Nayagram, Kuilibandh, Swargabati and Indkata to record pattern of different plant species consumed by elephants. Total number of each plant consumed with respect to the total number of plants present in the plots was recorded through evidences of branch breaking, main-stem breaking, stem twisting, bark peeling, uprooting and tusk markings (Ishwaran 1983). The degree of utilization was calculated based on the ratio of total individual plants consumed to total number of plants in the plot.

Proximate and chemical analysis of plants

Proximate analysis of those food plants consumed by elephants has been done as per A.O.A.C. (1995). Sodium and potassium content of food plants were estimated using Flame Photometer (Model: Flame Photometer Burner Unit-121, Sistronics). Pressure was fixed at 0.5 kg/cm^2 and sensitivity was medium. Copper, manganese, zinc, iron and calcium content of food plants were determined by Atomic Absorption Spectrometer (Model: Perkin Elmer A-Analyst 100).

Results and Discussion

Dalma elephants consumed different plant species with varying degree of preferences. It was observed that seventeen plant species were utilized as food plants. They consumed either the whole plant or its parts viz. leaf, leaf with succulent stem, bark, fruit and root. Overall utilization of food plants by migratory elephants revealed that the *Diospyros melanoxylon* was utilized maximum (34.39%) followed by *Pterocarpus marsupium* (24.86%) among all the recorded plants. Though the density of *S. robusta* was highest in the study area, elephants utilized it very poorly (0.24-0.67%). The bark of *Ficus hispidus* was fully consumed wherever available. Bark of *Buchanania latifolia* was moderately utilized i.e. 10.58 percent. All other plants such as *Trewa nudiflora*, *Terminalia belerica*, *Lannea grandis*, *Butea superba* and *Aegle marmelos* were utilized below 10.0 percent. Bark of *Shorea robusta* was very poorly utilized (4.27%) in spite of their highest abundance in the forests. Out of total recorded plant species, five non-tree species (*Acacia chundra*, *Mucuna pruriens*, *Zizyphus xylopyrus*, *Butea superba* and *Smilax macrophylla*) were found to be consumed occasionally by elephants.

The chemical values of some wild plants consumed by elephants are given in the Table 1. Crude protein content varied form 3.18 (*S. robusta*) to 21.25 (*P. marsupium*) g per cent. Leaf and entire plants were found to have higher crude protein than that in bark and roots. *Ichnocarpus frutescens* contained highest ether extract (3.64%) followed by that in *P. marsupium* (3.42%) and *T. tomentosa* (3.30%). Crude fibre content ranged from 20.0 (*P. marsupium*) to 54.0 (*D. melanoxylon*) percent. Root of *D. melanoxylon* and bark of *Careya arborea* had higher crude fibre i.e. 54 and 51 percent respectively. Total ash varies from 3.25 (*T. tomentosa*) to 8.73 (*B. superba*) percent.

The neutral detergent fibre (NDF), acid detergent fibre (ADF) and lignin contents of some wild plants are summarized in Table 2. NDF content ranged from 57.0 (*T. nudiflora*) to 74.0 (*G. arborea*) percent. ADF content ranged from 24.8 (*D. melanoxylon*) to 40.0 (*G. arborea* and *L. grandis*) percent. Lignin content of studied plants ranged from 4.0 (*S. anacardium*) to 9.1 (*G. gumifera*) percent.

Mineral contents of some selected wild plants are given in Table 3. Sodium content of *T.tomentosa* bark was much higher (2.57 mg/g) as compared to other plants. The lowest sodium content was found in the bark of *S.robusta* (0.78 mg/g). Potassium content ranged from 18.76 mg/g (*S. robusta*) to 154.83 mg/g (*Gardenia gummifera*). Except *S. robusta*, barks contained higher amount of potassium in other plants. Calcium content in bark ranged from 7.34 mg/g in *Careya arborea* to 32.50 mg/g in *T. tomentosa*. However, *A. marmelos* contained lowest amount of calcium (0.40 mg/g). Iron contents ranged from 0.16 to 3.18 mg/g in studied plants. However, the iron content was much higher in roots of *D. melanoxylon* (3.18 mg/g) and *S. anacardium* (2.38 mg/g) than the other parts of various plants analyzed. Copper content varied from 0.03 (*B. latifolia*) to 1.42 mg/g (*S. robusta*). Roots of *S. anacardium* was found to have highest amount of manganese (0.77 mg/g) followed by that in *T. nudiflora* bark (0.59 mg/g). Lowest manganese content was found in the fruits of *A. marmelos* (0.02 mg/g). Zinc content ranged from 0.01 mg/g to 3.36 mg/g.

Species	Part analyzed	Moisture (%)	Dry matter (%)	Ether extract (%)	Crude fibre (%)	Crude protein (gm/100gm)	Acid insoluble ash(%)	Total ash (%)
Shorea robusta	Bark	7.4	92.6	3.23	40.0	3.18	2.0	5.36
Careya arborea	Bark	9.4	90.6	1.10	51.0	5.37	2.0	4.41
Diospyros melanoxylon	Root	14.4	85.6	1.16	54.0	5.0	1.0	6.88
Ichnocarpus frutescens	Entire plant	17.8	82.2	3.64	36.0	15.0	1.0	8.57
Kuttikalai (local name)	Entire plant	8.2	91.8	2.17	50.0	11.0	1.0	6.50
Terminalia tomentosa	Leaf	9.25	90.75	3.30	22.0	9.43	2.0	3.25
Butea superba	Entire plant	9.0	91.0	2.19	39.0	15.25	1.0	8.73
Ptercarpus marsupium	Leaf	12.4	87.6	3.42	20.0	21.25	2.0	8.56
Gmelina arborea	Bark	12.0	88.0	2.27	50.0	11.37	1.0	7.91

Table 1. Chemical composition of some wild plants (on dry matter basis) consumed by elephants in South Bengal forests.

Plant	Parts analyzed	DM (%)	NDF (%)	ADF (%)	Lignin (%)
Pterocarpus marsupium	Leaf	89.5	64.2	35.0	6.7
Pterocarpus marsupium	Bark	93.2	60.3	30.1	6.0
Trewia nudiflora	Bark	91.5	57.0	31.3	7.1
Gmelina arborea	Bark	88.0	74.0	40.0	7.5
Buchanania latifolia	Bark	88.1	73.2	34.8	6.9
Smilax macrophylla	Whole plant	90.3	61.2	29.2	5.4
Acacia chundra	Whole plant	93.3	58.4	30.0	6.0
Careya arborea	Bark	90.0	69.9	36.2	7.1
Diospyros melanoxylon	Root	92.0	58.5	24.8	4.2
Semecarpus anacardium	Root	85.5	65.6	27.5	4.0
Lannea grandis	Leaf	89.6	70.0	37.7	7.8
Lannea grandis	Bark	90.0	71.2	40.0	9.0
Gardenia gumifera	Whole plant	87.0	68.3	39.0	9.1

Table 2. The neutral detergent fibre (NDF), acid detergent fibre (ADF) and lignin contents of some wild plants.

Utilization pattern of wild plant species by migratory elephants in South West Bengal forest revealed that elephants were highly selective in taking food plants. Only 17 plant species were found to be utilized either fully or partially as evidenced by branch breaking, main-stem breaking, stem twisting, debarking, uprooting and trunk markings. A few plant species consumed by the migratory elephants in the wilderness is due to their dependency on cultivated crops which have higher palatability and nutritive value than wild plants. Two plant species *D. melanoxylon* and *P. marsupium* were highly preferred by elephants as food. Though heavy debarking of *Pterocarpus* spp in rain forest of Malayasia was reported (Olivier 1978), yet Dalma elephants showed strong preference for leaves of *P. marsupium*. As *P. marsupium*, *D. melanoxylon* and *B. latifolia* are utilized more by elephants these plants therefore should be protected by dissuading people from cutting.

High protein content of *P. marsupium* leaves (21.25 g/100 g) is probable reason for its highest degree of utilization. This can be supported by the fact that ungulates can select food of desired nutritive value by applying their nutritional wisdom (Field 1976). Debarking of many food plants in the wilderness has been observed. Feeding on bark may help maintain an optimum fibre: protein ratio to ensure proper digestion of protein (Laws *et al.* 1975), or supply minerals such as manganese, boron, copper, iron and calcium (Bax and Sheldrick 1963). Bark of some plants has been observed high mineral contents viz. iron, copper and manganese in the present study. The present finding is corroborated with Dougall *et al.* (1964). There has been a positive correlation between degree of debarking by

Plant	Parts analyzed	Na	K	Ca	Zn	Mn	Cu	Fe
Pterocarpus marsupium	Leaf	1.01	67.25	8.92	3.36	0.45	0.31	0.20
Pterocarpus marsupium	Bark	1.17	67.26	7.52	1.26	0.06	0.23	0.20
Trewia nudiflora	Bark	1.33	54.74	25.66	0.03	0.59	0.09	0.24
Gmelina arborea	Bark	1.19	101.66	19.44	0.71	0.04	0.17	0.24
Buchanania latifolia	Bark	1.33	84.45	22.72	1.74	0.04	0.03	0.20
Smilax macrophylla	Whole plant	0.89	78.20	8.18	0.07	0.45	0.07	0.45
Acacia chundra	Whole plant	1.01	106.35	6.28	0.68	0.27	1.28	0.16
Careya arborea	Bark	1.38	140.76	7.34	0.01	0.09	-	0.66
Diospyros melanoxylon	Root	1.19	53.17	20.66	0.14	0.11	0.25	3.18
Semecarpus anacardium	Root	1.03	73.50	12.90	0.23	0.77	0.66	2.38
Lannea grandis	Leaf	1.08	57.86	13.66	0.01	0.37	0.04	0.91
Lannea grandis	Bark	1.47	98.53	13.80	-	0.22	0.06	0.54
Gardenia gumifera	Whole plant	1.56	154.83	18.80	0.01	0.30	0.09	2.05
Shorea robusta	Bark	0.78	18.76	1.70	0.67	0.05	1.42	0.28
Terminalia tomentosa	Bark	2.57	51.61	32.50	0.12	0.11	0.35	0.26
Aegle marmelos	Fruit	1.15	112.60	0.40	0.03	0.02	0.25	0.39

Table 3: Mineral composition of some selected wild plants (mg/g).

elephants and calcium content of plant species as observed by Laws *et al.* (1975). In the present investigation *B. latifolia* bark with high calcium content (22.72 mg/g) was consumed at moderate level (10.58%). However, some other plant species with high calcium content viz. *T. nudiflora* (25.66 mg/g) and *T. tomentosa* (32.50 mg/g) were found to be utilized very poorly (0.52%). These plant species may contain higher amount of toxic alkaloid leading to their poor utilization. As elephants are known to be prone to sodium deficiency (Benedict 1936; Olivier 1978), they visit salt-lick to consume certain soils rich in minerals (Sukumar 1985). In the present investigation elephants consumed some plant species having higher sodium and other mineral contents. The role to trace elements viz. zinc, manganese, copper and iron in elephant nutrition has not been properly elucidated (Sukumar 1985). However, the analyzed plant samples found to contain comparatively high level of trace elements was possibly due to the soil composition of South Bengal. Though some factors such as food-dispersal pattern, nutritive value and toxicity are important in influencing selection of food plants by elephants (Olivier 1978), it is unlikely that any single factor would explain the elephant's preferences (Ishwaran 1980).

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