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EXPERIMENTAL PAPER

Quantitative ethnomedicinal study of plants used to cure different ailments in Rajaji tiger reserve, Uttarakhand, India

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Summary

Introduction: India has a rich diversity of ethnomedicinal plants where the preparations from plants are used in treatment of various infection and ailments.

Objectives: The detailed survey was done to gather the information about potential preparation of ethnomedicinal plants by the local communities of the study area.

Methods: Data on 54 ethnomedicinal plants were recorded with the help of 19 men and 18 women aged between 45 and 60. Direct observation, group discussion and semi structured interview were used to collect the ethnobotanical information of the study area.

Results: Prevalent ethnomedicinal uses of the plants were used for treating diarrhoea, asthma, dysentery, and other human ailments. The most commonly plant parts gathered were leaves (28.78 %) followed by bark (19.69 %), root (12.12 %), flower (10.60 %), fruit (9.09 %), seed and whole plant (7.57 % each), stem (4.54 %). It was observed from the investigation that the ethnomedicinal plants used most frequently in the treatment of diarrhoea and dysentery (29 taxa) followed by other liver problems (7 taxa), healing cut and wounds, tooth problems, blood dysentery, piles, asthma, fractured bones, scorpion/insects bite (2 taxa), skin diseases, urinary disorder and headache, menstrual disorder, infertility, stone problems, cold and cough, muscle pain and swelling, memory enhancer, killing of liver worms in children, insects repellent, bronchial catarrh (1 taxa each).

Conclusion: The folk knowledge and ethnomedicinal preparation recorded in the present study area can be implemented in future for pharmacological and biological assay which could be further lead to new drug development.

Key words: ***ethnobotany, ethnomedicinal plants, Rajaji Tiger Reserve, quantitative analysis***

Słowa kluczowe: ***etnobotanika, rośliny stosowane w medycynie ludowej, Rezerwat Tygrysów w Rajaji, analiza jakościowa***

INTRODUCTION

Ethnomedicinal plants play a significant role in primary healthcare in different countries due to cultural norms, traditional beliefs, low cost and availability [1]. In past, the relation of people and plant has evolved into multi-disciplinary way which includes anthropology, botany, and pharmacognosy [2]. In last two decades, role of ethnobotany has been boosted up and ethnobotanist has applied the quantitative methods to enumerate the data by applying the hypothesis in context of the relation of human and plants [3]. Therefore, various ethnobotanical indexes have evolved to measure the ethnic diversity of plant, people and their relations with the environment [4]. These quantitative indices of ethnobotany were used to measure plant as a food, fodder and as a remedial medicine. Although the scope, subject and purpose of quantitative ethnobotanical measures is to enumerate the importance of indigenous and ethnic knowledge, it also determines the relation of people with plants and environment. In spite of a large number of developments in the field of ethnobiology, the role of applying quantitative methods has been increased. At the same time, folk knowledge and ethnomedicinal remedies also has been decline generation after generation. There was no single study conducted in Rajaji Tiger Reserve on the status of ethnomedicinal plants due to its isolation from main city, harsh environmental conditions, lack of good roads and transportation problems.

METHODOLOGY

Study area and people

In the view of traditional knowledge on folk medicine, an attempt was made to study the medico-ethnobotanical features of the plants from Rajaji Tiger Reserve lying between 29°15' to 30°31' N, 77°52' to 78°22' E, at an altitude of 250–1100 m. The information was obtained from Kumao chaur, Kumbi chaur, Talla chaur, Kodiya talla and Kunao in Gohri bank in Rajaji Tiger Reserve. We have also collected information from local people of Kodiya talla and malla villages, Kimsar in Pauri Garhwal. Information was also correlated with earlier Scopus data on the communities of Western Himalaya. The dense vegetation is contiguous with the Chilla-Gohri forest range of tiger reserve which makes it a unique repository of biodiversity in Northern India. Climatic is generally hot, along with humid condition. The temperature raises up to 40–45°C in summer and 20–25°C in winter. The annual rainfall ranges from 1200 to 1500 mm in the study area. The highest range of rainfall occurs from May to July at the time of Southeast monsoon and October to November during Northeast monsoon [5]. There is a very little data about herbal remedies used by the communities residing in Rajaji. The Gujjars, a forest dwelling tribe, live in and around the forest of Rajaji Tiger Reserve. Gujjars live together as a small community in Gohri forest range of the reserve, whereas Gujjars of Chilla were rehabilitated [6]. The traditional occupation of Gujjars and other locals includes rearing of cattle for milk, ghee and supplying it to the market areas. They also prepare medicines at a small production level and sell it into the market. Furthermore, they also used to collect the various non-timber forest products, such as bee wax, honey, ethnomedicinal plants, resin and gum. They have been used different treatments to cure various ailments. The knowledge originates from their ancestors [7]. The aim of present investigation was to enumerate and document the ethnomedicinal wealth used by the indigenous groups in Rajaji Tiger Reserve of Northern India (fig. 1, tab. 1).

Table 1.

District area of Rajaji Tiger Reserve

	District	Area [ha]
1.	Dehradun	23677.90
2.	Pauri Garhwal	25007.70
3.	Haridwar	33356.59
	Total	**82042.19**

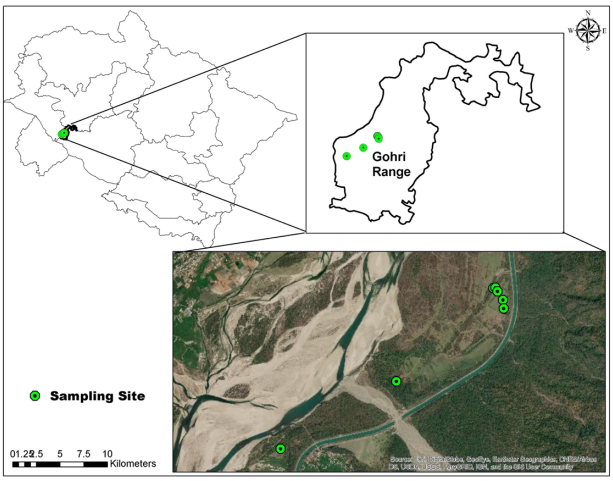

Figure 1.

Map of Uttarakhand state showing Gohri forest range of Rajaji tiger reserve

Data collection

The ethnobotanical survey was carried out from 2016 to 2019 with the help of medical professionals, taxonomist and plant scientist. There were three local forest guards who helped reach all the sites of the Rajaji Tiger Reserve where the indigenous groups reside. Traditional medical healers were asked to take part in the scientific research. A total of 54 ethnomedicinal plants were collected with the help of 37 traditional medical healers. The group of 19 men and 18 women aged between 45–60 was interviewed. Direct observation, group discussion and semi-structured interview were used to collect the ethnobotanical information. On the other hand, methods of curing, plant parts used, methods of medicinal dose preparation and its administration were also recorded in the survey. Furthermore, every traditional healer was asked about the diagnosis of a particular ailment. The preliminary identification of plants was done with the help of traditional healer and other locals. The collected information from the interviewed person was also discussed with them so that large groups of people can be benefitted. Maximum groups of Gujjars are illiterate but they all transfer traditional information between generations. The specimens collected from the study area were identified with the help of local flora and information available on the books [8, 9] and further validate through herbarium reference of Botanical Survey of India. The data was also compared with earlier related research from the study area and a published book [7, 9, 10].

Ailment categories

The information recorded was arranged into different categories of illnesses, such as diarrhoea and dysentery, liver problems, fever, urinary ailments, kidney stone, asthma etc.

DATA ANALYSIS

Informant consensus factor (Fic)

The Fic was calculated for the use of plant parts in established categories of ailments. The Fic was calculated by following method described in [11]:

$$Fic = \frac{Nur - Nt}{Nur - 1},$$

where Nur – total number of use-report for an ailment category and Nt – number of ethnomedicinal plants used for curing a particular ailment category. In general, the product of Fic varied from 0 to 1.

Use value (UV)

Use value (UV) is referred as the relative importance of an ethnomedicinal plant for curing a particular ailment and it can be found out by following formula [12]:

$$UV = \frac{\Sigma U}{n},$$

where UV – use value of a plant species, U – number of use reports cited by a participant for a given ethnomedicinal plant species, n – total number of participants interviewed for an ethnomedicinal plant.

Fidelity level (FL)

Fidelity level (FL) is generally used to determine the most frequent ethnomedicinal plant species used for curing a particular ailment. It can be calculated by following method [13]:

$$FL(\%) = \frac{Np \times 100}{N},$$

where Np – number of use-reports cited for a given ethnomedicinal plant species for a particular ailment category, N – total number of use reports cited for given species.

Frequency of citation (FC) and relative frequency of citation (RFC)

Frequency of citation (FC) is generally used to find the preferred ethnomedicinal plant species. On the other hand, relative frequency of citation (FC) was used to find out the knowledge of traditional usage of ethnomedicinal plants. It can be calculated as

$$RFC = \frac{FC}{N(0 < RFC < 1)},$$

where RFC – relative frequency citation, FC – frequency of citation, N – whole number of informers.

RESULTS

Documentation and knowledge

In present study, 54 ethnomedicinal plant species were used as herbal remedies for the treatment of various ailments. Informants from tribal Gujjars showed higher knowledge of ethnomedicinal plants as compared to the other local villagers. The reason might be the fact that most of tribal Gujjars are ethnomedicinal plant gatherers, peddlers and traditional healers, whereas the local villagers are farmers and small vendors. During the study, out of the 54 ethnomedicinal plants 25 were trees, 7 shrubs, and 22 were herbs. All plants are used in different ailments, moreover, single plant is used in more than one ailment. It was observed that the ethnomedicinal plants were most frequently used in the treatment of diarrhoea and dysentery (29 taxa) followed by other liver problems (7 taxa), healing cuts and wounds, tooth problems, blood dysentery, piles, asthma, fractured bones, scorpion/insects bite (2 taxa), skin diseases, urinary disorders and headache, menstrual disorders, infertility, stone problems, cold and cough, muscle pain and swelling, memory enhancer, killing of liver worms in children, insect repellent, bronchial catarrh (1 taxon each). Gastrointestinal disorders and associated problems were treated with the maximum diversity of ethnomedicinal plants. It was also observed that ethnomedicinal plants diversity increases as the core area reduces. This is because human activities are not allowed in the core zone of tiger reserve. In buffer zone, natural sources are dwindling due to Gujjars and the activities of villagers.

(a)

(c)

(b)

(d)

Figure 2 (a-d).

View of Gujjars's Sheltars (Deras) - the study area

Quantitative analysis of ethnomedicinal plants

Quantitative parameters determine the prediction of the species use in different ailments and importance of particular species in area. Questionnaires along with different tools of ethnobotanical studies were needed so that exact quantification of data could be done by cross verification of traditional information to cure various human ailments in the study area. *Ficus racemosa* (UV=0.134) has been observed for highest use value, followed by *F. benghalensis, Helicteres isora* and *Bidens pilosa* (UV=0.062), *Rumex hastatus* and *Oxalis corniculata* (UV=0.061), *Ougeinia oojeinesis* (UV=0.060) had a very low use value (UV=0.023) (tab. 2). The RFC in our study varied from 0.10 to 0.27. Furthermore, we have categorized ethnobotanical species into 3 parts: RFC 0.10 to 0.16 (19 species); RFC 0.17 to 0.19 (21 species); RFC 0.20 to 0.27 (14 species) (tab. 2). In present study, highest relative frequency values were recorded for *Ziziphus nummularia* (0.27) used in diarrhoea as a decoction, *Syzygium cumini* (0.25) in diarrhoea and dysentery, *Vitex negundo* (0.22) used in diarrhoea in a form of powder. Ethnomedicinal plant species which also has shown the moderate RFC value were *Terminalia bellirica, Cuscuta reflexa, Tridax procumbens, Parthenium hysterophorus* etc. We examined the specific human ailment categories to focus the most important ethnomedicinal plant species in each category diseases in terms of FL. In present study highest Fidelity value was FL = 95.67 which is recorded for *Boehmeria rugulosa,* and lowest Fidelity value for *Butea monosperma* (FL=60.12). We have also categorized the Fidelity value into three different classes of 0–61 %, 62–90% and 91–95.67%. We have recoded 1 species in 0–61% fidelity level, 41 species in 62–90% fidelity level and 12 species in 91–95.67% fidelity level. We have recorded species like *Ziziphus nummularia*, *Phyllanthus emblica*, *Celosia argentea*, *Colebrookia oppositifolia, Mallotus philippensis, Terminalia chebula, Mimosa pudica, Fagopyrum esculentum, Cassia fistula, Ficus auriculata* for highest fidelity level value in the study area.

Table 2.

Quantitative ethnobotanical study among indigenous groups of Rajaji Tiger Reserve

Plant name	Family name	Local name	Habit	Collector No. assigned	Mode of utilization	Disease treated	Plant part used	UV	RFC	FL	Reference
Adhatoda vasica Medik.	*Acanthaceae*	Vasaka	S	RNP-102	powder	cold and cough, amoebic dysentery	Rt	0.057	0.11	61.12	[24]
Achyranthus aspera Linn.	*Amaranthaceae*	Apamarg, Chirchita, Latjeera	H	RNP-143	powder	toothache, muscular pain	L	0.032	0.17	81.25	[9, 32]
Chenopodium album L.	*Amaranthaceae*	Bathua	H	RNP-157	fried	bladder stone	L.	0.056	0.11	82.32	[8, 9]
Celosia argentea L.	*Amaranthaceae*	Garkha	H	RNP-118	decoction	diarrhoea	L	0.027	0.18	90.42	[9]
Amaranthus paniculatus L.	*Amaranthaceae*	Marchu	H	RNP-125	fried	killing of liver worm in children	Sd	0.032	0.18	96.87	[8, 9]
Amaranthus spinosus L.	*Amaranthaceae*	Chaulayi	H	RNP-147	fried	snake and scorpion bite	L	0.031	0.18	81.25	[8, 9]
Centella asiatica L.	*Apiceae*	Bhrami	H	RNP-148	extract/ powder	memory enhancer	L	0.055	0.12	83.31	[8, 9]
Holarrhena pubescens G.Don	*Apocynaceae*	Kutaj	T	RNP-132	infusion	dysentery	Br	0.034	0.14	71.42	[34]
Ageratum conyzoides L.	*Asteraceae*	Jangli pudina	H	RNP-149	paste	cuts and wound dressing	L	0.040	0.11	71.91	[8, 9]
Bidens pilosa L.	*Asteraceae*	Kunwar	H	RNP-151	paste	skin infection	L	0.062	0.19	83.85	[40]
Eclipta alba Hassak.	*Asteraceae*	Bhringraj	H	RNP-152	extract/ powder	liver problems	L	0.040	0.11	71.91	[40]

Table 2. (*continued*)

Plant name	Family name	Local name	Habit	Collector No. assigned	Mode of utilization	Disease treated	Plant part used	UV	RFC	FL	Reference
Parthenium hysterophorus L.	*Asteraceae*	Gajarghas	H	RNP-153	paste	insect bites, toothaches and infertility	L	0.051	0.21	79.40	[9]
Tridax procumbens L.	*Asteraceae*	Ghamra	H	RNP-154	powder	repellent, bronchial catarrh and diarrhoea	Wp	0.051	0.21	79.40	[9]
Xanthium strumarium L.)	*Asteraceae*	Ghokru	H	RNP-155	powder	tooth infection	L	0.056	0.10	83.32	[42]
Oroxylum indicum L.	*Bignoniaceae*	Bhutiya talwar	T	RNP-134	extract	diarrhoea and dysentery	Rt, Fl	0.022	0.18	75.47	[9, 33]
Bombax ceiba L.	*Bombacaceae*	Semal	T	RNP-135	extract	joint pain, digestive disorders, piles	Fl	0.025	0.22	74.00	[34]
Celtis australis Linn.	*Cannabaceae*	Khadeek	T	RNP-145	powder	fractured bone and constipation	Br, Sd	0.032	0.17	81.25	[39]
Terminalia bellirica (Gaertner) Roxb.	*Combretaceae*	Bahera	T	RNP-162	extract/ powder	dysentery and diarrhoea	Fr	0.051	0.21	79.40	[9]
Cuscuta reflexa Roxb.	*Convolvulaceae*	Amarbel	H	RNP-158	paste	insect repellent	Wp	0.051	0.21	79.40	[43]
Anogeissus latifolia Roxb.exDC.	*Combretaceae*	Bakuli	T	RNP-103	powder	diarrhoea and dysentery	L	0.021	0.15	72.15	[35]
Terminalia chebula Retz.	*Combretaceae*	Heda	T	RNP-136	extract/ powder	asthma, indigestion	Fr	0.020	0.19	95.87	[9, 32]
Mallotus philippensis Muell-Arg.	*Euphorbiaceae*	Runi	T	RNP-137	powder	constipation	Fr	0.031	0.17	95.87	[9, 32]
Acacia nilotica L.	*Fabaceae*	Kikar	T	RNP-126	powder	dysentery	Br	0.027	0.21	74.00	[8, 9]
Bauhinia variegata L.	*Fabaceae*	Gwiryal	T	RNP-127	decoction	killing of worm in stomach	Fl, L	0.026	0.21	74.00	[9, 29]
Cassia fistula L.	*Fabaceae*	Amaltas	T	RNP-120	powder	dysentery and joint pain	Br	0.022	0.19	95.87	[9]
Butea monosperma Taub	*Fabaceae*	Dhak or Plas	T	RNP-128	extract	dysentery	Sd, Fl	0.046	0.12	60.12	[31]
Mimosa pudica L.	*Fabaceae*	Lajwanti	H	RNP-131	powder	jaundice and dysentery	Wp	0.020	0.17	95.87	[9, 33]
Acacia catechu (L. f.) Willd.	*Fabaceae*	Kattha	T	RNP-101	powder	dental problem	Rt	0.134	0.16	78.33	[9]
Albizia lebbeck (L.) Benth.	*Fabaceae*	Sirish	T	RNP-105	powder	diarrhoea and dysentery	Br, Sd	0.058	0.21	86.11	[36]
Dalbergia sissoo DC.	*Fabaceae*	Shiham	T	RNP-116	powder	blood dysentery and diarrhoea	L,Br	0.027	0.16	73.65	[41]
Ougeinia oojeinensis (Roxb.) Hochr.	*Fabaceae*	Sandan	T	RNP-165	infusion	diarrhoea and dysentery	Br	0.060	0.11	71.91	[46]

Table 2. (*continued*)

Plant name	Family name	Local name	Habit	Collector No. assigned	Mode of utilization	Disease treated	Plant part used	UV	RFC	FL	Reference
Ocimum santum L.	*Lamiaceae*	Tulsi	H	RNP-122	paste	cold and cough, diarrhoea and menstrual disorder	L	0.040	0.11	71.90	[9]
Colebrookia oppositifolia Smith.	*Lamiaceae*	Binda	S	RNP-138	powder	wound	L	0.031	0.17	95.87	[9]
Vitex negundo L.	*Lamiaceae*	Nirgundi	S	RNP-161	powder	diarrhoea	Fl	0.053	0.22	76.31	45]
Litsea chinensis Lour.	*Lauraceae*	Kuda	T	RNP-140	extract	fractured bones	Br	0.056	0.10	83.32	[37]
Woodfordia fruticosa Kurz.	*Lythraceae*	Dhaula	S	RNP-142	powder	piles	Fl	0.034	0.18	82.25	[38]
Sterculia villosa Roxb.	*Malvaceae*	Udal	T	RNP-156	juice	blood dysentery	Rt	0.050	0.11	72.91	[8]
Tinospora cordifolia (Willd.) Miers	*Memispermaceae*	Giloy	H	RNP-163	extract/ powder	diarrhoea, chronic dysentery	Wp	0.052	0.20	78.40	[45]
Ficus racemosa L.	*Moraceae*	Gular	T	RNP-119	latex	stomach problem and dysentery	St	0.028	0.20	75.37	[9,26]
Ficus benghalensis L.	*Moraceae*	Bargad	TF	RNP-129	infusion	stomach problem and dysentery	Br	0.062	0.19	83.84	[32]
Ficus auriculata L.	*Moraceae*	Timla	T	RNP-123	latex	stomach problem and dysentery	St	0.025	0.20	90.42	[27]
Syzygium cumini (L.)	*Myrtaceae*	Jamun	T	RNP-164	extract	dysentery and diarrhoea	Rt	0.022	0.25	91.00	[27]
Boerhavia diffusa L.	*Nyctaginaceae*	Chota ghokru	H	RNP-110	paste	liver problems and bloody dysentery	Rt	0.024	0.18	70.75	[9]
Oxalis corniculata Linn.	*Oxallidaceae*	Khatti buti	H	RNP-146	raw	toothache, fever	L	0.061	0.18	83.75	[34]
Argemone mexicana L.	*Papaveraceae*	Kantkari	H	RNP-108	powder	diarrhoea and dysentery	Sd	0.028	0.22	81.58	[25]
Phyllanthus emblica Linn.	*Phyllanthaceae*	Anwla	T	RNP-139	powder	hair falling/asthma and indigestion	Fr, L	0.031	0.17	95.87	[28]
Cynodon dactylon L.	*Poaceae*	Dubla	H	RNP-114	powder	diarrhoea, dysenthery and urinary infection	Wp	0.030	0.15	87.60	[9, 30]
Fagopyrum esculentum Moench.	*Polygonaceae*	Bhettu	H	RNP-121	decoction	urinary disorder and headache	Rt, L	0.041	0.22	94.00	[9,28]
Rumex hastatus D.Don.	*Polygonaceae*	Almera	H	RNP-144	paste	cut and wound	L	0.061	0.1	83.84	[8,9]
Ziziphus nummularia (Burm. f.) Wight&Arn.	*Rhamnaceae*	Baer	S	RNP-159	decoction	dysentery	Br	0.023	0.27	90.00	[44]
Ziziphus mauritiana Lam.	*Rhamnaceae*	Badi baer	T	RNP-160	powder	diarrhoea	Rt, Br	0.056	0.12	82.32	[9, 32]

Table 2. (*continued*)

Plant name	Family name	Local name	Habit	Collector No. assigned	Mode of utilization	Disease treated	Plant part used	UV	RFC	FL	Reference
Madhuca longifolia J.F.Macbr.	*Sapotaceae*	Mahua	T	RNP-133	infusion	diarrhoea	Fl	0.032	0.15	71.42	[32]
Helicteres isora L.	*Sterculaceae*	Marorfali	S	RNP-130	powder/ decoction	diarrhoea and dysentery/cold and cough	Fr	0.062	0.17	83.84	[8, 9, 32]
Boehmeria rugulosa. Wedd.	*Urticaceae*	Ghenthein	S	RNP-141	infusion	fractured bone/ liver disorder	St, Fr	0.030	0.18	96.87	[8, 9]

L – leaves, Br – bark, Fl – flower, Wp – whole plant, Fr – fruit, Rt – root, Sd – seed, St – stem, H – herb, S – shrub, T – tree

Methods of administrations of ethnomedicinal plants

Nine different categories of methods of administrations have been established, out of which the most frequently used form was powder (38.89%) followed by extract (14.81%), paste (12%), infusion (11.11%), decoction (7.40 %), fried (5.55 %), latex (3.70 %), raw and juice (1.85% each). Furthermore, the most commonly used plant parts gathered were leaves (28.78%) and bark (19.69%) followed by root (12.12%), flower (10.60%), fruit (9.09%), seed and whole plant (7.57% each), stem (4.54%). It was observed that powder preparation for curing an ailment is a common practice among tribal Gujjars in the study area. The fresh or dried plant parts were collected for making the paste after grinded it with water or oil or honey. The preparation 'decoction' was prepared by boiling plant parts in water until the water volume remained in a minimum amount.

Ingredients used

It was observed that the tribal Gujjars and local phadi completes the medicinal arrangements with a single part of ethnomedicinal plant or in mixture of various plant parts. In present study area, single mode of drug preparation has been dominating by multiple modes. The locals used groups of plants for drug preparation for the treatment of multiple ailments or one only. This is due to the fact that multiple plant remedies for an ailment among the traditional Gujjar or medicinal healer could be attributed to the belief of synergic reactions where single plant could have a potentiating effect on the other in that particular ailment. Gujjar also thought that multiple preparation for an ailment has a great pharmacologically and biologically active compounds. The multi-herbal curation has higher capacity of curing power than single used ethnomedicinal plant treatment. Latex of *Ficus auriculata, F. racemosa* are mixed collectively and given in diarrhoea and dysentery. *Phyllanthus emblica, Terminalia bellerica, T. chebula* which is collectively known as 'Triphala' used in stomach disorder by Gujjar and pahadi people. Gujjar too frequently use some additional ingredients such as cow/goats milk, honey, Ghee, sugar, salt, coconut milk and coconut water to improve the medicinal property and acceptability of certain remedies. Powder of *Vitex negundo* was given with cow milk to treat diarrhoea, whereas the juice of *Sterculia villosa* mixed with honey used against blood dysentery.

DISCUSSION

The present study was carried out among the native groups of Rajaji Tiger Reserve which is an important area of Northern India. Indigenous groups have used different plants for curing different diseases. Generally, the ethnomedicinal plants are used in backward part of the area. The greater group of traditional healers in present study consisted of men. It was observed that about 84% of total rural population worldwide depend on ethnomedicinal plants in curing various diseases [14]. Mostly, traditional knowledge has been inherited generation after generation [15]. The inherited knowledge of ethnomedicinal plants is transferred from one generation to another orally which is a cultural practice and is frequent in the less developed areas [9]. The most dominant were herbs. The main reason for this is their easily availability from roadsides and farmlands so can be collected easily [16]. *Asteraceae/Fabaceae* were the most dominant family in the study area. Our results are comparable with the earlier studies

of worker [9, 17] whose study reported *Asteraceae* with the leading family in terms of highest number of ethnomedicinal plants. Plant families like *Asteraceae* and *Fabaceae* have been reported to have high pharmacological and antimicrobial properties [18]. It was also observed from the earlier reports that *Asteraceae* is one of the dominant families of medicinal plants. Approximately, there are more than thee lakhs species of flowering plants in world, in which *Asteraceae* contribute in about 10% [9, 19]. This is due to the fact that *Asteracae* have wider adaptability and usual occur in all habitats.

The powder form of ethnomedicinal plants has been the most preferred method of utilization in different ailments. In present study, most commonly used preparation was powder (38.89%) followed by extract (14.81%), paste (12%), infusion (11.11%), decoction (7.40%), fried (5.55%), latex (3.70%), raw and juice (1.85% each). The use of decoction and powder are one of major modes of utilization of herbal preparations by different communities of Northern India [20]. The herbal preparations were applied on affected areas for 2–3 times daily until healing occurred. Further, it was also observed that in maximum herbal preparation includes soaking of ethnomedicinal plants for 3-4 days in water and taking it in form of infusion, while other includes boiling the different plant part and taking it in form of decoction.

The ethnomedicinal plants recorded in present study can also be utilized additionally for their pharmacological and phytochemical activities. The highest UV for important ethnomedicinal plants are as follows: *Ficus racemosa* (UV=0.134), *F. benghalensis, Helicteres isora* and *Bidens pilosa* (UV=0.062), *Rumex hastatus* and *Oxalis corniculata* (UV=0.061), *Ougeinia oojeinesis* (UV=0.060). They could be ascribed to the trends of use of the drugs for curing different human ailments in the study area. Furthermore, it was also observed that the species which is most frequently used in different ailments might have great biological and wound healing activity [21].

It was revealed that all medicinal plant species were previously recorded for one or two biologically active compounds. During phytochemical analysis

Table 3.

Quantitative ethnobotanical parameters for commonly used plants

S. No.	Category of ailments	Nt	Nur	Fic	Plant parts used
1.	Diarrhoea dysentery and dysentery	4 25	6 24	0.44	bark, roots, leaves, seeds, bark, whole plant, latex, gum, flowers, fruit
2.	Killing of liver worms in infants	1	3	1	seeds
3.	Urinary disorder and headache	1	4	1	root
4.	Menstrual problems	1	3	0.42	leaves
5.	Women infertility disorders	1	4	0.46	leaves
6.	All liver ailments	10	7	0.56	leaves, fruits, stem, bark, seeds
7.	Stone problems	1	5	1	roots, leaves
8.	Blood dysentery	2	4	0.44	roots
9.	Cold and cough	1	3	1	leaves, fruits
10.	Muscle pain and swelling	1	6	1	bark, leaves, roots
11.	Skin problems with cut and wound	3	7	0.46	oil, leaves, root whole plant
12.	Insects repellent	1	4	0.45	whole plant whole plants
13.	Piles	2	4	0.44	flowers, gums
14.	Asthma	2	6	0.59	fruit, leaves, seeds
15.	Fractured bones	2	5	0.43	bark, wood
16.	Scorpion/insects bite	2	4	0.42	leaves
17.	Memory booster	1	3	1	leaves
18.	Tooth problems	4	4	0.34	leaves

*A – taxa may be reported in more than one ailment category

Nur – Number of use reports, Nt – Number of taxa, FIC – Informant consensus factor

of plants like *Adhatoda vesica, Boerhavia diffusa, Bidens pilosa, Eclipta alba, Vitex negundo, Syzygium cumini, Boerhavia diffusa, Butea monosperma, Rumex hastus, Ageratum conyzoides, Achyranthus aspera* from present study the identification of different alkaloids, mesaconitine and benzoyl mecasonine was performed. Some species like *Terminalia bellirica, Brassica compestris, Fagopryum esculantum, Ficus racemosa, Ocimum sanctum, Bauhinia variegata* from studied ethnobotanical plants are slightly poisonous when used in the excess amount, but limited amount made a positive effect on health. It was observed that the high FL value of a species indicates the choice of cure of particular ailment [22]. The highest fidelity value was FL=95.67 recorded for *Boehmeria rugulosa.* Other species like *Mallotus philippensis, Mimosa pudica*, *Cassia fistula, Phyllanthus emblica, Boehmeria diffusa, Amaranthus paniculatus, Terminalia chebula, Colebrookia oppositifolia* were also found in the study area. These plants may provide biological actions. In our study, 70 FL% or greater significance of plant species was found. Ethnomedicinal plant with high RFC can be used in further different analysis due to their active biological compounds for drug discovery [23]. The highest relative frequency values were recorded for *Ziziphus nummularia* (0.27) used in diarrhoea as decoction, *Syzygium cumini* (0.25) used in diarrhoea and dysentery, *Vitex negundo* (0.22) used in diarrhoea as powder in present study area. So, the present study clearly demonstrated that apart from many conventional methods of use of the ethnomedicinal plants could be important in novel drug discovery.

CONCLUSIONS

The present study provides the information about the utilization of 54 plant species for treatment of different human ailments by the indigenous communities of Rajaji Tiger Reserve. This tiger reserve is an important part of Western Himalaya in Northern India. The key findings study revealed that powder form (38.89%) is the most frequently used ethnomedicinal preparation followed by extract (14.81%), paste (12%), infusion (11.11%), decoction (7.40 %), fried (5.55%), latex (3.70%), raw and juice (1.85% each). The human ailments treated with ethnomedicinal plants were diarrhoea and dysentery followed by liver problems and others (tab. 3). *Ficus racemosa* has been observed for highest UV value (UV=0.134), whereas *Boehmeria rugulosa* (FL=95.67) has been observed for highest FL value. Plant species like *Cassia fistula, Mallotus philippensis, Colebrookia oppositifolia, Phyllanthus emblica, Boehmeria rugulosa, Amaranthus paniculatus, Terminalia chebula, Mimosa pudica* also has shown great quantitative ethnobotanical parameters from present study area. The folk knowledge recorded in the present study area can be implemented in future for pharmacological and biological assay which could be further lead to nano-medicine and in novel drug development (fig. 3–5).

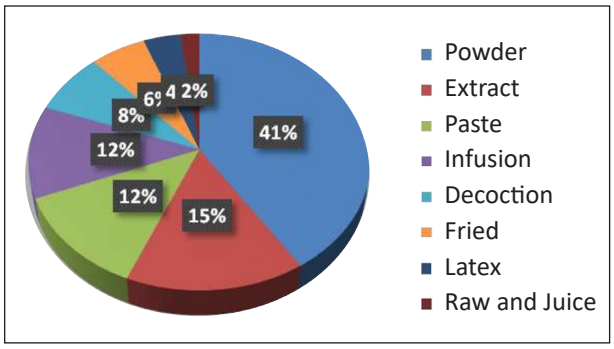

Figure 3.
Mode of utilization of ethno-medicine by the indigenous groups of Rajaji tiger reserve

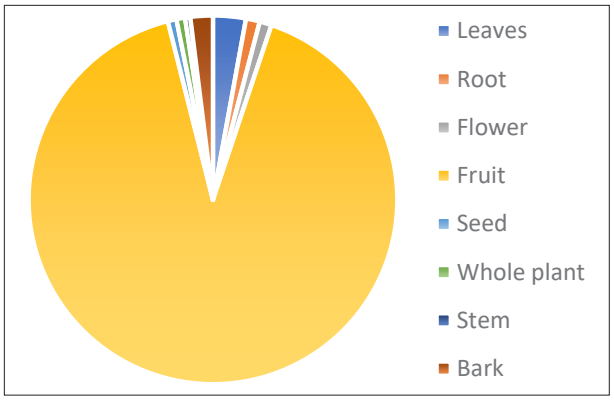

Figure 4.
Plant parts used

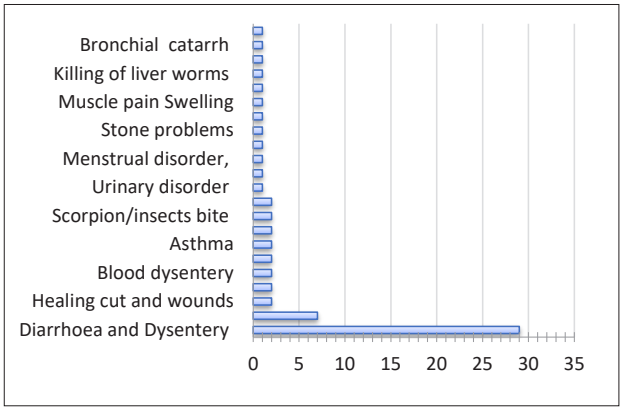

Figure 5.
Ethnomedicinal plants used in different ailments

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