

Figure 9. Comparative representation of Asr curve for different latitudes.

minima coincide on the summer solstice day. A similar coincidence happens on the winter solstice day at the Tropic of Capricorn.

Figure 9 shows a more realistic representation in polar coordinates, including additional azimuthal data for places from the equator to 60° lat., exhibiting interesting shape of the Asr curve.

The Moti Masjid sundial, though a fine piece of art, has been useless for centuries and in wrong orientation. Because of its simple, single Asr curve, the dial is also significantly different from the one at Srirangapatna¹. Srirangapatna, being situated in the tropics, witnesses the Sun's zenithal passage twice a year. The size of the lower part of the Asr curve beyond the cusp signifies how close the place is to the tropical lines. Since the Sun never reaches the zenith beyond the tropics, the lower part of the Asr curve disappears.

The Asr prayer time in Agra practically extends up to sunset. It is time for the fourth prayer—Maghrib at sunset. We could successfully determine the appropriate length 5.625 inches of the missing original gnomon of the sundial in Agra by carrying out computer simulations, followed by on-site observations to resolve a long-standing puzzle.

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Traditional knowledge of medicinal plants among the Thangal–Naga ethnic group of Manipur, India

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With a population of 4475 individuals, the Thangal–Naga of Manipur is one of the vulnerable schedule tribe groups in India. During the study, oral traditional knowledge for the treatment of ailments using wild medicinal plants by the ethnic group was documented. Forty-one ethnomedicinal plants from 40 genera and 28 families were reported during the semi-structured interviews of 70 locals. In total, 29 different ailments were treated using medicinal plants. Further, phytochemical analysis of 11 common medicinal plants revealed the presence of alkaloids, flavonoids, saponins, tannins, phenols, steroids, anthraquinones, coumarins, glycosides and terpenoids.

Keywords: Ethnomedicinal plants, ethnic groups, phytochemical analysis, Thangal–Naga, traditional knowledge.

THANGAL–Naga, also known as Koirao, is one of the endangered, small, tribal ethnic groups in India with a population of 4475 individuals, and represents 0.38% of Manipur's tribal population¹. Today, there are only 11 villages in Senapati district of Manipur, viz. Angkailongdi,

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Table 1. Plants used in traditional medicine among the Thangal–Naga ethnic group

Scientific name, family and voucher number	Vernacular name (Thangal)	Habit	Parts used	Ailment treated and other uses	Preparation/ formulation	Routes of administration	Edible use
Acanthaceae							
<i>Phlogacanthus thyrsoformis</i> Nees BP-2019/22	Tamphanggan	Shrub	Lf	Cold	Boiled Juice	Oral/ inhalation/bath	Fw as kanghou; Lf as chutney
Anacardiaceae							
<i>Rhus semialata</i> Murray BP-2019/07	Khama	Tree	Fr	Gastric problem	Decoction	Oral	Fr as raw
Apiaceae							
<i>Centella asiatica</i> (L.) Urb. BP-2019/30	Jopikonggan	Herb	Wp	Stomach problems, blood purifier, enhanced eyesight	Decoction	Oral	Wp as kangsu and chamfut
<i>Eryngium foetidum</i> L. BP-2019/14	Majangmikikhom	Herb	Lf	Epilepsy, paralysis and high blood pressure	Paste/decoction/ fresh	Topical/ oral	Lf as spice
Apocyanaceae							
<i>Rauwolfia serpentina</i> (L.) Benth. ex Kurz BP-2019/12	Parisaikoi	Herb	St	Skin infection	Paste	Topical/ massage	–
Asteraceae							
<i>Eupatorium adenophorum</i> Spreng. BP-2019/37	Japan phana	Herb	Ts, Lf	Cuts and wounds	Paste	Topical	–
<i>Ageratum conyzoides</i> (L.) L. BP-2019/08	Majangmi phana	Herb	Lf	Cuts and wounds	Paste	Topical/ massage	–
<i>Artemisia nilagirica</i> (C.B. Clarke) Pamp. BP-2019/01	Tampitangou	Herb	Lf, Ts	Dysentery	Fresh/juice	Topical/oral	–
<i>Gynura cusimbua</i> (D. Don) Moore. BP-2019/35	Leishak phana	Herb	Lf	Gastric problem and cleansing of stomach	Decoction	Oral	–
<i>Spilanthes acmella</i> (L.) L. BP-2019/06	Shagitla	Herb	Fw	Toothache and gastric problems	Fresh	Oral	–
Bignoniaceae							
<i>Oroxylum indicum</i> (L.) Kurz. BP-2019/41	Chakkoi	Tree	Br, Fr	Piles and cancer	Juice	Oral	Fr as chutney
Caricaceae							
<i>Carica papaya</i> L. BP-2019/26	Koigithei	Tree	Lf	Headache, gastric and stomach problems	Decoction	Oral	Fr as fresh
Cucurbitaceae							
<i>Momordica charantia</i> L. BP-2019/17	Khalaganthei	Climber	Lf	Flu and cold	Decoction	Oral	Fr as chutney or boiled; Lf as fresh
<i>Echinocystis lobata</i> (Michx) Torr. & A. Gray BP-2019/18	Ram githei phana	Climber	Wp	Jaundice	Decoction	Oral	–
Cyperaceae							
<i>Fuirena umbellata</i> Rottb. BP-2019/33	Ngi	Herb	Rt	Fever, swelling of arms, legs and stomach problem	Decoction	Oral	–
Lamiaceae							
<i>Mentha spicata</i> L. BP-2019/23	Nungsit pari	Herb	Lf, Ts	Stomach problems	Decoction	Oral	Ts as flavour- ing agent
<i>Ocimum canum</i> Sims. BP-2019/09	Hopae	Herb	Lf, Ts	Headache	Decoction	Oral	Ts as flavour- ing agent
Lauraceae							
<i>Cinnamomum verum</i> J. Presl BP-2019/02	Sangleikoi	Tree	Br	Cough, pain/ itching	Juice/fresh	Oral/ topical	Br as spice
Liliaceae							
<i>Allium hookerii</i> Thwaites BP-2019/32	Sanamnamchenga	Herb	Lf	Deworming	Paste	Topical/ massage	Wp as chamfut and as chutney
<i>Allium sativum</i> L. BP-2019/15	Sanamriba	Herb	Lf	High blood pressure, cough and cold	Juice	Oral	Bl as spice

(Contd)

Table 1. (Contd)

Scientific name, family and voucher number	Vernacular name (Thangal)	Habit	Parts used	Ailment treated and other uses	Preparation/ formulation	Routes of administration	Edible use
Lythraceae							
<i>Punica granatum</i> L. BP-2019/20	Pulangtheikoi	Tree	Rt	Dysentery	Juice	Oral	Fr as fresh
Meliaceae							
<i>Azadirachta indica</i> A. Juss. BP-2019/04	Neemkoi	Tree	Lf	Fever and cough	Decoction	Oral	–
Mimosaceae							
<i>Mimosa pudica</i> L. BP-2019/40	Kajakpi phana	Herb	Wp	Piles and stone problems	Decoction	Oral	–
<i>Parkia javanica</i> Merr. BP-2019/34	Kajongtakkoi	Tree	Fr	Diarrhoea and dysentery	Boiled juice	Oral	Fr as singju and iromba; Fw as singju
Musaceae							
<i>Musa paradisiaca</i> L. BP-2019/39	Poitheikoi	Tree	Fr	Diarrhoea	Fresh	Oral	Fw as fried item; St as iromba; Fr as fresh
Myristicaceae							
<i>Myristica linifolia</i> Roxb. BP-2019/25	Ripkoi	Tree	Lf	Cuts and wounds	Paste	Topical/ massage	–
Oxalidaceae							
<i>Oxalis corniculata</i> L. BP-2019/29	Pit	Herb	Lf	Indigestion and gastric problem	Decoction	Oral	Lf as kangsoi
Plantaginaceae							
<i>Plantago major</i> L. BP-2019/38	Kapatnougan	Herb	Lf	Blood clot and boils	Paste	Topical/ massage	Lf in iromba
Poaceae							
<i>Cynodon dactylon</i> L. BP-2019/05	Phlim	Herb	Wp	Fever and typhoid	Juice	Oral	–
Rosaceae							
<i>Rubus ellipticus</i> Sm. BP-2019/03	Machikthei	Shrub	Rt	Diarrhoea	Juice	Oral	Fr as fresh
Rubiaceae							
<i>Meyna laxiflora</i> Robyns BP-2019/36	Habitheikoi	Tree	Lf	Swelling of the body	Decoction	Oral	Lf as fresh in singju; Fr as dried
<i>Paederia foetida</i> L. BP-2019/19	Beireng	Climber	Lf	Bone fracture	Paste	Massage/ topical	–
Rutaceae							
<i>Citrus limon</i> (Linn.) Burm. f. BP-2019/10	Champra	Shrub	Fr	Fever	Fresh	Massage	Fr as fresh
<i>Zanthoxylum acanthopodium</i> DC BP-2019/27	Ngangtheikoi	Tree	Fr	Toothache	Fresh	Oral	Fr in chutney; Lf as spice
Sapindaceae							
<i>Sapindus mukorossi</i> Gaertn. BP-2019/13	Talumthei	Tree	Fr	Fever and deworming	Juice	Topical/ massage	–
Saururaceae							
<i>Houttuynia cordata</i> Thunb. BP-2019/31	Dana	Herb	Wp, Rz	Muscle cramp, eye and skin irritation, measles, stomach ulcers	Decoction/ juice	Oral	Lf as fresh spice
Solanaceae							
<i>Solanum torvum</i> Sw. BP-2019/11	Khukthei	Shrub	Fr	Fever and typhoid	Juice	Oral	Fr as chutney
Verbenaceae							
<i>Clerodendrum colebrookianum</i> Walp. BP-2019/24	Pokdomna	Tree	Lf	Blood pressure	Decoction	Oral	Lf as curry
Zingiberaceae							
<i>Alpinia galangal</i> (L.) Willd. BP-2019/21	Jaikhaba	Herb	Rz	Cough and diarrhoea	Paste/ decoction	Topical/ oral	Rz as spice
<i>Curcuma longa</i> L. BP-2019/28	Marenggai	Herb	Rz	Swelling of the body	Paste	Topical/ massage	Rz as spice
<i>Zingiber officinale</i> Roscoe BP-2019/16	Saraikaga	Herb	Rz	Sore throat	Fresh	Oral	Rz as spice

Br, Bark; Fr, Fruits; Fw, Flowers; Lf, Leaves; St, Stem; Ts, Tender shoots; Rt, Roots; Rz, Rhizomes; Wp, Whole plants.

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Katomei Makeng, Makeng Cheijinba, Ngaihang, Mapao Thangal, Mayangkhang, Ningthoupham, Thangal Surung, Tumnoupokpi, Yaikongpao and Takaimei where Thangal habitations are found². Traditionally, Thangals are agriculturists and horticulturists with experience in jhum cultivation. The womenfolk are mostly skilled weavers making indigenous hand-woven clothes. They have lived with the sustainable use of forest and plant resources, such as wild edible plants, timber, fruits, medicinal herbs, flowers, orchids, etc. and depend on them directly or indirectly for their livelihood³. Like the major ethnic groups of Manipur, Thangals have acquired the traditional knowledge of using plants for healing different ailments since generations. They have maintained their own ethnic identity, customs, beliefs, faith and tradition. However, the indigenous traditional ways are disappearing from the society under the influence of modernization and industrialization. Today, lack of proper documentation has resulted in the disappearance of important ethnomedicinal knowledge from different indigenous ethnic groups, where the age-old traditions are being replaced by modern allelopathic practices. Therefore, there is an urgent need to update the traditional knowledge of these ethnic groups.

In this study, the ethnomedicinal knowledge was collected from 11 Thangal-inhabiting villages of Senapati district during 2018–19. Information on ethnomedicinal plants such as local name, ailments treated, plant parts used, preparation methods and administration routes was

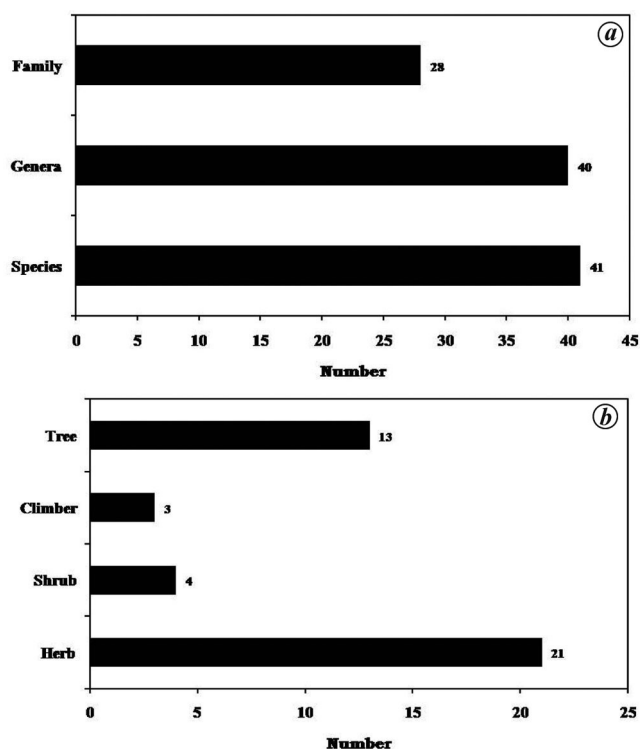


Figure 1. Distribution of (a) plant species, genera and families and (b) growth forms and habits.

collected using semi-structured interviews. Voucher specimens collected were identified with the help of experts and the available literatures^{4–6}. The scientific name and family were cross-checked using the PlantList (www.theplantlist.org) of the Royal Botanic Garden, Kew, UK. Voucher specimens (BP-2019/01 to BP-2019/41) were then deposited in the Department of Forestry and Environmental Science, Manipur University. Eleven common medicinal plants (*Cynodon dactylon* and *Centella asiatica* whole plant, *Oroxylum indicum* and *Cinnamomum verum* bark, *Eupatorium adenophorum* and *Ageratum conyzoides* leaves, *Musa paradisiaca* and *Solanum torvum* fruits, *Alpinia galangal* and *Curcuma longa* rhizomes and *Spilanthes acmella* flowers) were collected and qualitative analysis of the phytochemicals was performed (water extract)^{7,8}.

Among the 70 locals included in the ethnobotanical survey, 80% were men and 20% were women. A great disparity was noticed in the distribution of the traditional

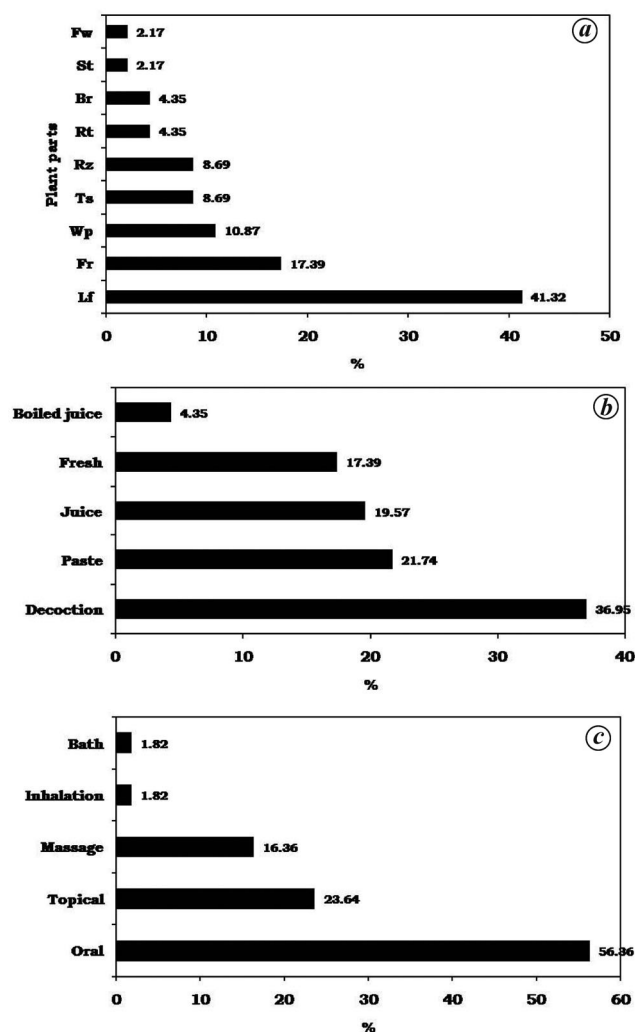


Figure 2. Percentage distribution of (a) plant parts used, (b) mode of preparation and (c) route of administration.

Table 2. Phytochemical screening of common medicinal plants

Plant	Phytochemicals									
	Flavonoids	Tannins	Phenols	Terpenoids	Steroids	Saponins	Anthraquinones	Coumarins	Glycosides	Alkaloids
<i>Cynodon dactylon</i>	+	-	+	-	-	+	-	+	-	+
<i>Centella asiatica</i>	+	+	+	-	+	-	-	-	-	+
<i>Oroxylum indicum</i>	+	-	-	-	-	+	+	-	-	+
<i>Cinnamomum verum</i>	-	-	-	+	-	-	+	-	-	+
<i>Eupatorium adenophorum</i>	-	+	+	-	+	+	+	-	-	+
<i>Ageratum conyzoides</i>	+	+	+	-	+	+	-	+	-	+
<i>Musa paradisiaca</i>	-	-	-	-	-	-	-	-	-	-
<i>Solanum torvum</i>	-	-	-	-	-	+	-	+	-	+
<i>Curcuma longa</i>	+	-	-	+	+	+	+	-	-	+
<i>Alpinia galangal</i>	-	-	-	-	-	+	-	+	-	+
<i>Spilanthes acmella</i>	+	-	-	-	+	-	-	+	-	+

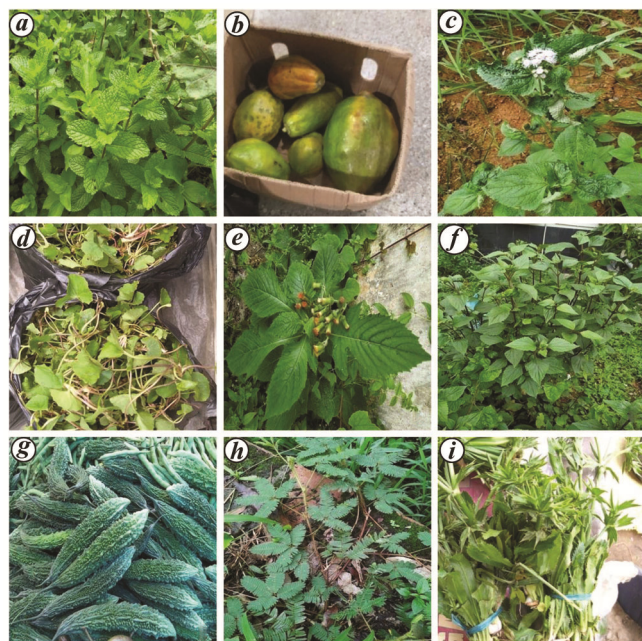


Figure 3. Photographs of common medicinal plants. *a*, *Mentha spicata*; *b*, *Carica papaya*; *c*, *Ageratum conyzoides*; *d*, *Centella asiatica*; *e*, *Gynura cusimbua*; *f*, *Eupatorium adenophorum*; *g*, *Momordica charantia*; *h*, *Mimosa pudica*; *i*, *Eryngium foetidum*.

knowledge between the sexes, where the tradition is a male-inherited system. Moreover, the healers mostly belonged to the aged population of the community with the younger generation favouring modern methods of treatment. During knowledge transmission, elders usually pass on the information and treatment processes to their near ones orally, thus restricting the number of individuals with the said knowledge. This is a common tradition observed in different indigenous groups^{9,10}. In total, 41

species from 40 genera and 28 families were documented (Table 1). *A. conyzoides*, *E. adenophorum*, *C. asiatica*, *C. dactylon*, *O. canum*, *P. thyrsoformis*, *P. major*, *S. torvum* and *Z. officinale* were commonly recommended by the healers. The maximum use reports were found for treating ailments such as gastric and stomach problems, fever, diarrhoea and dermatological problems due to their greater prevalence in the region¹. The common preferred species belonged to families Asteraceae, Zingiberaceae, Lamiaceae, Rubiaceae, Apiaceae, Liliaceae and Cucurbitaceae. Moreover, herbs were the major ethnomedicinal source, which explains the rich herbaceous species wealth of the region³ (Figure 1). The traditional healers generally used nine different plant parts during the preparation of crude drugs (Figure 2 *a*). The maximum use was reported for leaves (19 species), as the collection was easier and resources were available in large volumes compared to other parts. Moreover, the harvest of the leaves can cause minimum damage compared to other parts from the conservation point of view. Likewise, the parts were prepared under five categories and the crude drugs administered via five routes (Figure 2 *b* and *c*). The healers were well aware of the preparation methods and routes for administration, so that maximum efficiency could be achieved for the drug. Further, it was observed that most of the drugs were administered orally as it was the most effective means, which is similar to numerous findings^{11,12}. Moreover, 27 species from 26 genera and 21 families were consumed in the local households in traditional cuisines (Table 1 and Figure 3). Phytochemical analysis of the 11 ethnomedicinal plants showed the presence of flavonoids, tannins, phenols, terpenoids, saponins, coumarins, anthocyanin, anthraquinones, glycosides, alkaloids and steroids (Table 2). The analysis supports the selection of a particular species by the healers for traditional medicine. Thus,

the present study highlights the rich, disappearing, traditional ethnomedicinal knowledge which is scattered in oral form within the Thangal–Naga ethnic group of Manipur. Such knowledge needs proper documentation for use, preservation and protection.

Conflict of interest. Authors declare no conflict of interest.

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