

## Cultural roots of healing: exploring traditional medicine practices of the Nocte tribe of Arunachal Pradesh

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Traditional medicine plays a vital role in the survival of Indigenous tribal communities in remote rural regions of Arunachal Pradesh, where access to modern healthcare system is often limited. This study documents the traditional medicinal knowledge related to flora and fauna utilized by the Nocte tribe of Arunachal Pradesh over two years (2022-2024) through semi-structured questionnaires. The study identified the use of 34 plant species across 22 families, primarily targeting gastrointestinal issues (45%), blood coagulation (19%), and high blood pressure (9%). Informant Consensus Factor (ICF) analysis showed a high degree of knowledge homogeneity (ICF=1.00) for plants used to treat typhoid, colds and coughs, dental issues, and general illnesses. High use value (UV=2.00) was recorded for species including *Artemisia* sp., *Solanum aethiopicum*, *Solanum indicum*, *Centella asiatica*, *Zanthoxylum armatum*, *Curcuma longa*, *Goniothalamus* sp., and *Terminalia chebula*. The highest family use values (FUV=2.00) were observed in the Apiaceae, Annonaceae, and Combretaceae families. Several species, including *Ageratum conyzoides*, *Artemisia* sp., *Chromolaena odorata*, *Mikania scandens*, *Oxalis corniculata*, *Solanum* spp., *Centella asiatica*, *Citrus medica*, *Zanthoxylum* sp., *Clerodendrum venosum*, *Curcuma longa*, *Zingiber officinale*, *Emblia officinalis*, *Goniothalamus* sp., *Hydrocotyle sibthorpioides*, *Musa paradisiaca*, and *Potentilla indica*, exhibited a Relative Frequency of Citation (RFC=1.00), indicating high recognition among informants. Additionally, the study found that 11 animal species, predominantly mammals (64%), were also utilized medicinally. *Hystrix brachyura*, *Apis mellifera*, and *Apis cerana* had the highest RFC (0.034), indicating less use frequency compared to plants. This study highlights the importance of documenting and preserving this eroding traditional knowledge, to revitalize its relevance among younger generations and protect the cultural heritage of these communities.

**Keywords:** Arunachal Pradesh, Indigenous communities, Nocte, Traditional knowledge, Traditional medicine

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Traditional folk medicine is a widely accepted therapeutic entity and plays a crucial role in healthcare, in several underdeveloped and developing countries<sup>1</sup>. Ethnomedicine, the use of natural resources like plants and animals for healing by various ethnic cultures, represents traditional knowledge passed down orally through generations<sup>2</sup>. The WHO<sup>3</sup> estimates that about 80% of the global population relies on it as their main healthcare<sup>4</sup> due to factors like location, culture, or cost limiting access to conventional medicine<sup>5</sup>. Ethnomedical practices exhibit significant inter-cultural variability. For instance, Traditional Chinese Medicine (TCM) employs acupuncture and herbal remedies, while Ayurveda in India emphasizes balance through diet and lifestyle changes. These systems are characterized by their holistic approach, treating not just the

physical symptoms but also psychological and spiritual well-being<sup>6</sup>.

Medicinal plants in many cultures are a source of income and affordable healthcare<sup>2</sup>. In Asia, countries like Japan and China have long utilized the healing properties of plants. Japanese honeysuckle (*Lonicera japonica*) is a prime example, employed to combat colds and flu<sup>7</sup>. Ginseng (*Panax ginseng*) another popular Asian herb, is revered for its energy-boosting and cognitive-enhancing properties in China and South Korea<sup>8</sup>. Even Indigenous African cultures have harnessed the power of plants, such as the antioxidant-rich and calming *Aspalathus linearis* ('Rooibos') commonly consumed as herbal tea<sup>9</sup>. The periwinkle plant (*Catharanthus roseus*), native to Madagascar, has yielded crucial compounds used in cancer treatments<sup>10</sup>. However, it is used by the rural folks on external wounds and to relieve wasp sting pain. It also acts as a blood coagulant, helping in healing bleeding wounds<sup>11</sup>.

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While plants are commonly used in traditional medicine, animals and their by products also play significant roles in various cultures as medicine. In TCM, Tiger bone is used as medicine to treat rheumatism, arthritis, and other inflammatory conditions<sup>12</sup>. It is also believed that consuming Deer velvet antlers enhances sexual function, promotes overall health<sup>13,14</sup> and also suppresses tumour formation<sup>15</sup>.

In European cultures<sup>16</sup>, cod liver oil has been a long-standing remedy for rickets as it is rich in vitamins A and D, which was clinically explained and confirmed by Dr. Harriette Chick and her co-workers in 1919 and 1922<sup>17</sup>. Additionally, bee products have been widely used in Western medicine. Honey has been applied topically to treat external wounds like burns, insect bites, skin diseases, and ulcers. Bee venom has contributed to treating rheumatoid arthritis, while bee pollen is considered to possess antibacterial, anti-fungal, antiviral, and anti-inflammatory properties<sup>18</sup>.

Ethnomedicine in India has two streams, first, the local folk stream prevalent in rural and tribal villages of India which are carried through several generations orally, and second, the scientific or the classical system (Ayurveda) consisting of codified and organised medical explanations covering all branches of medicines and surgery<sup>19</sup>. The major difference between Ayurveda and ethnomedicine is that Ayurveda mostly utilises herbal plants and some animal products like ghee, milk, honey, cow urine, and cow dung but does not use meat or flesh of animals nor perform any religious rites to treat diseases<sup>20</sup>. The northeastern part of India, consisting of more than 200 ethnic tribes has distinct cultures and traditions<sup>21</sup> and practices ethnomedicine, a knowledge passed down orally through generations over several decades. This practice is crucial as primary healthcare especially when access to modern medicines is limited. The ethnic groups of this region utilise various flora and fauna for medicinal purposes<sup>22</sup> of which 1,953 ethnomedicinal plants<sup>23</sup> and 930 zootherapeutic species<sup>24</sup> have been documented, highlighting the immense potential of traditional remedies. These indigenous communities of Northeast India, especially Arunachal Pradesh, have relied on plant-based remedies for generations, utilizing a diverse range of local flora and fauna to treat various ailments<sup>25</sup> with studies documenting the use of medicinal plants and animal

products by tribes like the Adi, Nyishi, Mishmi, Apatani, Tangsa, and Wancho and others<sup>24,26,27</sup>. These practices often involve complex formulations, including combinations of plants, animal products, and minerals. For instance, the Adi tribe<sup>28</sup> uses *Aconitum heterophyllum* as an antidote for snake bites and treats muscle pain and inflammation, while the Nyishi tribe<sup>29</sup> employs *Swertia chirayita* for curing malarial fever, high blood pressure, and flu. Animal-based remedies include the use of bear bile, musk deer musk, and snake venom for various ailments<sup>26</sup>.

However, the oral transmission of this knowledge and the erosion of traditional lifestyles pose a significant threat to this valuable heritage<sup>24</sup>. To address this issue, a primary hypothesis was developed stating that the Nocte tribe of Arunachal Pradesh possesses a rich and diverse ethnomedicinal knowledge system, encompassing the utilisation of a wide array of local flora and fauna for treating various ailments, which is primarily transmitted orally across generations. While crucial for their primary healthcare, this knowledge is vulnerable to erosion due to changing lifestyles and the lack of formal documentation. Therefore, the community was selected to augment existing ethnobotanical data and establish a baseline for the study of animal-derived medicinal knowledge.

#### Study area

Tirap district, located in the southeastern part of Arunachal Pradesh, India covers an area of 1,170 sq. km. The landscape comprises tropical and subtropical wet evergreen forests, grasslands, and bamboo. The climate of Tirap district is mainly cold, moist, and humid. It receives an average rainfall of 3479 mm where monsoon sets in May-June and lasts till September and the cold season prevails from November to February. The district lies between latitudes 26° 38' N and 27° 47' N, and longitudes 96° 16' E and 95° 40' E bordering the Dibrugarh district of Assam to the west, Myanmar to the east, Nagaland to the south, and Lohit district to the north Figure 1. The Nocte tribe inhabits it along with the Ollo and Tutsa sub-tribes having a total population of 55,022 after district bifurcation (with Longding as a new district). The district is rich in biodiversity and has a variety of flora and fauna; the local people depend on these resources to sustain themselves. The traditional knowledge passed down verbally through several generations is used in their daily lives for survival and is the foothold of their culture and traditions.

## Methodology

### Data collection

Field surveys using semi-structured questionnaires<sup>30</sup> were conducted from January 2022 to January 2024 (24 months) in 92 villages in Tirap district of Arunachal Pradesh. Interviews were conducted with 204 individuals within the 18-80 age groups, including hunters, local healers, and knowledgeable village elders. Furthermore, interviews were conducted in the local dialect, Nocte, to enhance communication, facilitating the collection of vernacular names of the

flora and fauna species for documentation purposes. Fauna species were identified from "Indian Mammals: A Field Guide" by Menon<sup>31</sup>, and collected plant specimens were identified by Tangjang *et al.*<sup>32</sup>, Namsa and Tangjang<sup>33</sup>, Perme *et al.*<sup>34</sup>, Wangpan *et al.*<sup>35</sup>, and further aided by the taxonomists of the Department of Botany, Rajiv Gandhi University, Arunachal Pradesh.

### Data analysis

The study area was mapped using ArcMap 10.8. The ethnobotanical data Table 1 collected were subjected to quantitative analysis to determine the informant

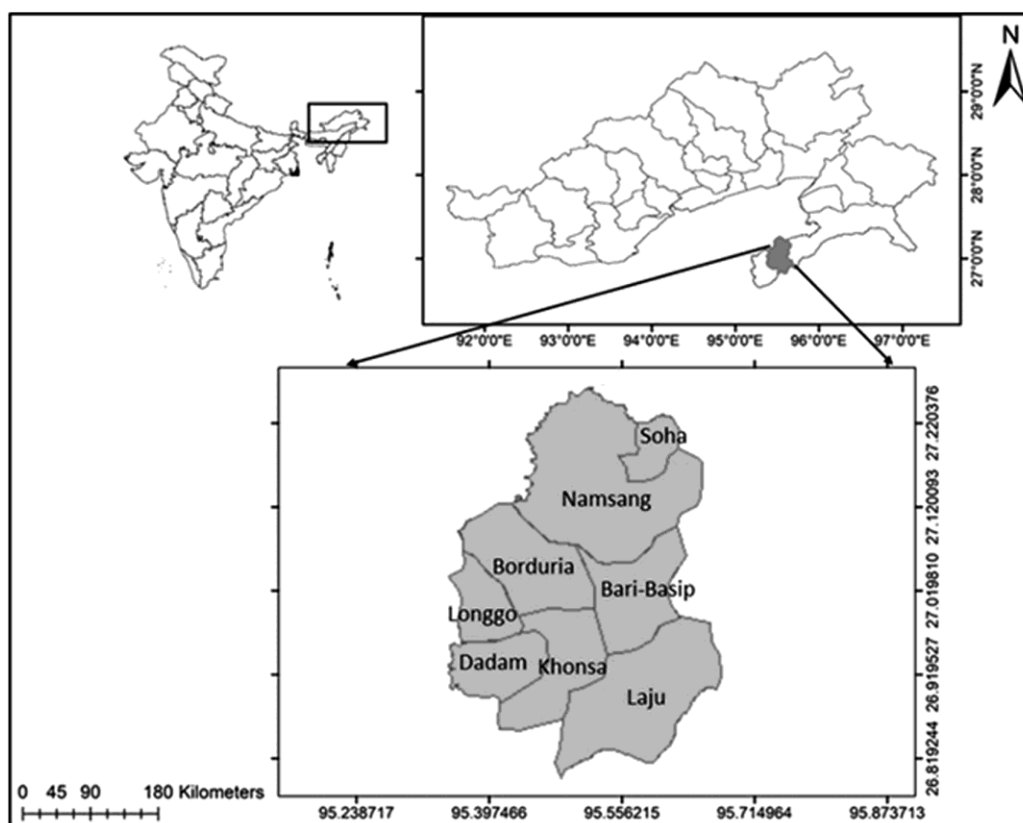


Fig. 1 — Location of study sites in Tirap district, Arunachal Pradesh (Created using ArcMap 10.8)

Table 1 — Ethnobotanical indices used for the study

Ethnobotanical index	Abbreviation	Equation	Equation description	Reference
Informant consensus factor	ICF	$\frac{(N_{ur} - N_t)}{(N_{ur} - 1)}$	$N_{ur}$ = Number of use reports per ailment $N_t$ = Number of plant species or taxa	Heinrich <i>et al.</i> , 1998 <sup>38</sup>
Use value	UV	$\frac{\sum U_i}{N}$	$U_i$ = Number of plant use reports $N$ = Total number of informants surveyed for a given plant	Phillips, 1996 <sup>39</sup>
Family use value	FUV	$\frac{UV_s}{N_s}$	$UV_s$ = Number of informants mentioning the family $N_s$ = Total number of species within each family	Sreekeesoon and Mahomoodally, 2014 <sup>37</sup>
Relative frequency citation	RFC	$\frac{F_c}{N}$	$F_c$ = Number of informants mentioning the use of the species $N$ = Total number of informants	Kufer <i>et al.</i> , 2005 <sup>40</sup>

consensus factor (ICF), use value (UV), family use value (FUV), and relative frequency citation (RFC). ICF is a widely used statistical tool that determines the level of homogeneity of knowledge among informants and analyses the overall use of plant species based on their cultural applicability<sup>36</sup>. family use value (FUV) is a quantitative metric used to determine the relative importance of plant families within a community. Relative frequency citation (RFC)<sup>37</sup> is a quantitative measure used to determine how often a particular plant species is mentioned as useful by informants within a community. This metric provides valuable insights into the most recognized and utilized plant species. Only the relative frequency citation (RFC) was calculated for zootherapy.

## Result

### Demography of the respondents

Out of 204 respondents, 91% were men and 9% women. The large gender gap is due to women's reluctance to be interviewed. Based on age, the respondents were divided into three age groups: 18-30 years (32.4%), 30-50 years (27.9%), and above 50 years (39.7%). About 15.25 were illiterate, while other 7.8% had attended school up to primary level, 62.3% to secondary level, and 14.7% to graduation level Table 2. Most respondents were farmers (38.2%), followed by college students (21.1%) and employees in government and private sectors.

### Taxonomic evaluation

The study recorded 34 medicinal plant species belonging to 22 taxonomic families, of which, the most common plant family used was Asteraceae (5 species),

followed by Solanaceae (3 species), Rutaceae (3 species), Oxalidaceae (2 species), Crassulaceae (2 species), Lamiaceae (2 species), Zingiberaceae (2 species) and Euphorbiaceae (2 species) Table 3 & Figure 2.

Similarly, 11 animal species belonging to 8 families are utilised in traditional medicine Table 4 & Figure 3. The highest number of species belonged to the Felidae (3 species) followed by Apidae (2 species).

Table 2 — Demography of the respondents (N=204)

	Number of respondents	Percentage (%)
Gender		
Men	185	91.0
Women	19	9.0
Age		
18-30	66	32.4
30-50	57	27.9
>50	81	39.7
Religion		
Animist	33	16.0
Christian	170	83.0
Hindu	1	1.0
Education		
Illiterate	31	15.2
Primary	16	7.8
Secondary	127	62.3
Graduate	30	14.7
Occupation		
Farmer	78	38.2
Government Employed	22	10.8
Student	43	21.1
Others (Private sector)	37	18.1
Unemployed	24	11.8
Annual Average Income		
<50000	156	76.5
50000-100000	44	21.6
>1 lakh	4	2.0

Table 3 — Phytomedicine practiced by Nocte tribe

Species name, specimen number	Common name/ Vernacular Name	Habit	Conservation status*	Parts used	Family	FUV	RFC	UV	Ethno-medical uses	Preparation
<i>Acmella paniculata</i> (Wall.ex DC.) R.K.Jansen (AIFW/FL/06)	Toothache plant	Herb	LC	Flower	Asteraceae	1.20	0.995	0.99	Toothache, Tooth decay	Paste applied on aching area
<i>Ageratum conyzoides</i> L. (AIFW/FL/07)	Billygoat weed	Weed	LC	Leaf, Stem	Asteraceae		1	1	Cut wounds, blood coagulant	Paste applied on cut wounds
<i>Artemisia</i> sp (AIFW/FL/47)	Mugwort	Shrub	---	Leaf	Asteraceae		1	2	Typhoid, Jaundice	Leaf decoction
<i>Chromolaena odorata</i> (L.) R.M. King & H. Rob. (AIFW/FL/37)	Siam weed	Shrub	LC	Leaf	Asteraceae		1	1	Cut wounds, blood coagulant	Paste applied on injured area
<i>Mikania scandens</i> (L.) Willd. (AIFW/FL/83)	Climbing hempvine	Climber	LC	Leaf	Asteraceae		1	1	Cut wounds, blood coagulant	Leaf paste applied to wounded areas

... Contd.

Table 3 — Phytomedicine practiced by Nocte tribe (Contd.)

Species name, specimen number	Common name/ Vernacular Name	Habit	Conservation status*	Parts used	Family	FUV	RFC	UV	Ethno-medical uses	Preparation
<i>Averrhoa carambola</i> L. (AIFW/FL/11)	Carambola (Star fruit)/ Koapdoh	Tree	LC	Fruit	Oxalidaceae	0.63	0.260	0.26	Jaundice	Raw
<i>Oxalis corniculata</i> L. (AIFW/FL/92)	Creeping woodsorrel/ Kosi	Herb	LC	Leaf, Stem	Oxalidaceae		1	1	Stomach-ache	Raw
<i>Bryophyllum</i> sp (AIFW/FL/19)	---	Shrub	---	Leaf	Crassulaceae	0.02	0.020	0.019	Stomach-ache	Raw, leaf decoction
<i>Kalanchoe</i> sp (AIFW/FL/115)	---	Shrub	---	Leaf	Crassulaceae		0.020	0.019	Burns, Cut wounds, blood coagulant	Leaf paste applied to wounded areas
<i>Camellia sinensis</i> L. (AIFW/FL/20)	Tea Plant/ Khelap	Herb	---	Leaf	Theaceae	0.64	0.319	0.64	Cleaning wounds, Stomach-ache	Decoction
<i>Capsicum frutescens</i> Rods. (AIFW/FL/21)	Bird Pepper/ Richik	Herb	LC	Fruit	Solanaceae	1.88	0.819	1.64	Blood coagulant, Antiseptic, Cut wounds	Raw
<i>Solanum aethiopicum</i> Jacq. (AIFW/FL/130)	Bitter tomato/ Kham-khah	Herb	LC	Fruit	Solanaceae		1	2	Stomach- ache, Control High Blood pressure	Boiled, Smoked
<i>Solanum indicum</i> L. (AIFW/FL/131)	Indian nightshade/ Soekhah	Shrub	NE	Fruit	Solanaceae		1	2	Stomach- ache, Control High Blood pressure	Boiled, Smoked
<i>Centella asiatica</i> (L.) Urb. (AIFW/FL/25)	Indian pennywort	Herb	LC	Leaf	Apiaceae	2.00	1	2	Cut wounds, Diarrhoea	Paste applied on injured area, Leaf decoction for diarrhoea
<i>Citrus medica</i> (L.) (AIFW/FL/38)	Lemon/Makri	Tree	LC	Fresh and fermented Fruit	Rutaceae	1.67	1	1	Stomach-ache	Fruit decoction,
<i>Zanthoxylum armatum</i> DC. (AIFW/FL/140)	Rattan Pepper/ Charuh	Tree	LC	Fruit, Seeds	Rutaceae		1	2	Fever, Stomach-ache	Decoction
<i>Zanthoxylum rhetsa</i> (Roxb.) DC. (AIFW/FL/141)	Indian prickly ash/ Makkat	Tree	LC	Fruit, Seeds	Rutaceae		1	1	Stomach-ache	Decoction
<i>Clerodendrum venosum</i> Wall. ex C.B. Clarke (AIFW/FL/43)	Glorybower/ Kharam	Shrub	NE	Leaf	Lamiaceae	0.51	1	1	Control High Blood Pressure	Boiled as vegetable
<i>Vitex negundo</i> L. (AIFW/FL/139)	Chinese chaste tree	Tree	LC	Leaf	Lamiaceae		0.020	0.019	Body pain	Leaf decoction
<i>Curcuma longa</i> L. (AIFW/FL/45)	Turmeric/ Halodi	Herb	LC	Rhizome, Zingiberaceae Root		1.50	1	2	Cut wounds, Sprain, Bone Fracture	Paste applied to the fractured area and kept for 5-7 days.
<i>Zingiber officinale</i> Roscoe (AIFW/FL/143)	Ginger/ Ching	Herb	LC	Rhizome	Zingiberaceae		1	1	Cough and Cold	Raw
<i>Emblica officinalis</i> Gaertn. (AIFW/FL/56)	Indian Gooseberry/ Phatmak	Herb	LC	Fruit	Euphorbiaceae	0.50	1	1	Stomach-ache	Raw

... Contd.

Table 3 — Phytomedicine practiced by Nocte tribe (Contd.)

Species name, specimen number	Common name/ Vernacular Name	Habit	Conservation status*	Parts used	Family	FUV	RFC	UV	Ethno-medical uses	Preparation
<i>Euphorbia</i> sp (AIFW/FL/68)	Spurge	Tree	---	Stem	Euphorbiaceae		0.005	0.005	Bone fracture	Stem pulp
<i>Goniothalamus</i> sp (AIFW/FL/75)	Koang-dak	Shrub/ Small tree	---	Leaf	Annonaceae	2.00	1	2	Stomach-ache, Headache	Dried leaves burnt and ash applied on stomach and head
<i>Hydrocotyle sibthorpioides</i> Colenso (AIFW/FL/77)	Lawn pennywort	Herb	LC	Whole plant	Araliaceae	1.00	1	1	Cut wounds, blood coagulant	Paste applied on injured area
<i>Musa paradisiaca</i> L. (AIFW/FL/89)	Banana/ Kiakke	Herb	LC	Fruit	Musaceae	1.00	1	1	Diarrhoea	Raw
<i>Passiflora edulis</i> Sims (AIFW/FL/104)	Passion fruit/ fruit	Tree	LC	Leaf	Passifloraceae	0.02	0.020	0.019	Diarrhoea	Leaf decoction
<i>Phlogacanthus thyrsoiflorus</i> (Roxb.) Nees (AIFW/FL/111)	Teetaphool/ Kelong	Shrub	NE	Leaf, Flower	Acanthaceae	0.32	0.324	0.32	Stomach-ache, gastritis, diarrhoea	Decoction
<i>Plantago</i> sp (AIFW/FL/120)	Plantain	Herb/ Sub-shrub	---	Leaf	Plantaginaceae	0.02	0.020	0.019	Constipation	Raw, Leaf Decoction
<i>Potentilla indica</i> (Andrews) Th.Wolf (AIFW/FL/127)	Mock Strawberry	Herb	LC	Leaf	Rosaceae	0.00	0.005	0.005	Thorn pricks	Leaf pulp applied to pricked area to remove thorns
<i>Psidium guajava</i> L. (AIFW/FL/128)	Guava/ Muthuliam	Tree	LC	Leaf, Fruit	Myrtaceae	1.00	1.000	1	Diarrhoea	Raw
<i>Sapindus mukorossi</i> Gaertn. (AIFW/FL/129)	Indian soapberry/ soapberry	Tree	LC	Fruit, Seeds	Sapindaceae	0.69	0.686	0.69	Cleansing (used as soap)	Raw
<i>Terminalia chebula</i> Retz. (AIFW/FL/132)	Black-chebulic myrobalan/ Hilikha	Tree	LC	Fruit	Combretaceae	2.00	1.000	2	Stomach-ache, Control High Blood Pressure	Raw, Sun-dried
<i>Tropaeolum</i> sp (AIFW/FL/138)	Nasturtium	Herb	---	Leaf	Tropaeolaceae	0.02	0.020	0.019	Gastritis, Acidity	Leaf decoction

\*LC-Least Concern, NE- Not Evaluated

### Phytomedicine

The survey documented a rich biodiversity of traditional healthcare resources used by the Noctes, including 34 plant species belonging to 22 families and 34 genera used to treat various ailments and external wounds. All these plants were grown in the vicinity of the homestead or were collected from the forest. The highest number of medicinal plants were herbaceous (n=14), followed by trees (n=10), shrubs (n=8), and one plant each of weed and climber. Leaves were the most frequently used plant part (18 species), followed by fruits (12 species), potentially minimizing the impact on whole plant populations Figure 4. The primary therapeutic applications targeted gastrointestinal disorders (20 species) like abdominal pain, diarrhoea, gastritis, constipation, and acidity, and external injuries, including cuts, burns, and punctures (10 species) Figure 5.

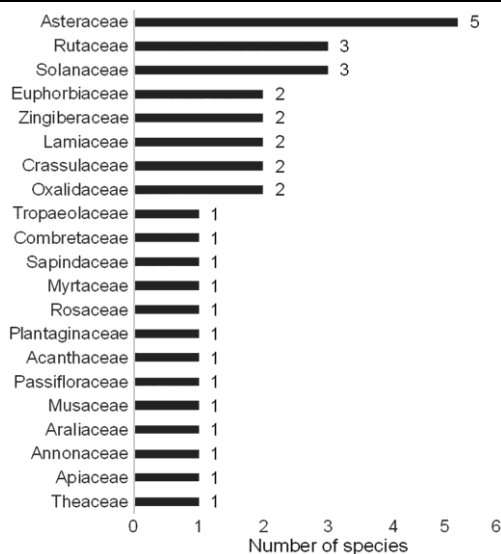


Fig. 2 — Family distribution of the ethnobotanically important medicinal plants

Most medicinal plants (45%) recorded were used to treat gastrointestinal complications like diarrhoea, constipation, and other stomach/bowel-related problems. 19% of medicinal plants were used as blood coagulants to stanch bleeding wounds followed by high blood pressure (9%), and Hepatitis A (5%). Plants for external wounds were typically crushed into

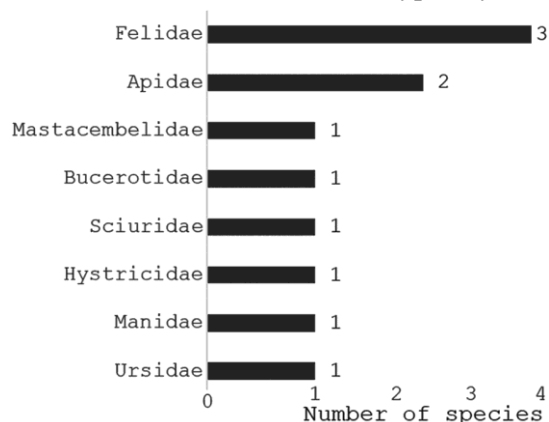


Fig. 3 — Family distribution of zootherapeutic animals

a paste and applied topically. For internal ailments, plant parts were generally consumed raw or ground, often mixed with water.

This practice represents fundamental first aid, often employed during hunting or foraging. Certain

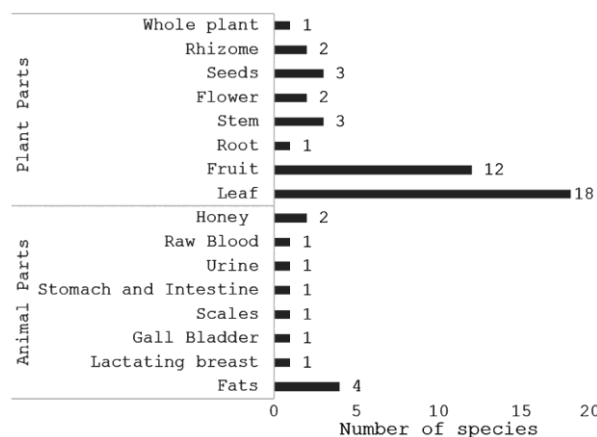


Fig. 4 — Medicinally useful parts and number of species in the medicinal practice of the Nocte tribe

Table 4 — Zootherapy practiced by the Nocte tribe

Scientific name	Family	Common name/ Vernacular name	IUCN status*	RFC	Parts used	Ethnomedicinal use	Preparations
<b>Mammals</b>							
<i>Panthera tigris</i>	Felidae	Tiger/Saa	EN		Fats, lactating breast	Muscle and joint pain, cut wounds, fissured heels	Raw
<i>Neofelis nebulosa</i>	Felidae	Indo-Chinese Clouded Leopard/Saa	VU		Fats	Muscle and joint pain	Raw
<i>Panthera pardus</i>	Felidae	Common Leopard/Ruh-Saa	VU		Fats	Muscle and joint pain	Raw
<i>Ursus thibetanus</i>	Ursidae	Asiatic Black bear/Sab-ba	VU	0.015	Gall bladder	Malaria, stomach- ache, gastritis	Dried and tiny bits are boiled in water
<i>Manis pentadactyla</i>	Manidae	Chinese Pangolin/Wichii	CR	0.005	Scales	Stomach-ache	Dried scales ground and mixed with water
<i>Hystrix brachyura</i>	Hystricidae	Himalayan Crestless Porcupine/Wiikha	LC	0.034	Stomach and intestine	Malaria, stomach- ache, gastritis, diarrhoea	Dried and tiny bits are boiled in water
<i>Petaurista petaurista</i>	Sciuridae	Red Giant Flying Squirrel/Loakla	LC	0.005	Urine	Kidney stones	Urine is absorbed in raw rice which is later boiled, and the water is separated and consumed
<b>Bird</b>							
<i>Buceros bicornis</i>	Bucerotidae	Great Hornbill/Waraa	VU		Fats	Cut wounds, fissured heels	Raw
<b>Fish</b>							
<i>Mastacembelus armatus</i>	Mastacembelidae	Zig-zag eel/ Nga-pu	LC	0.005	Raw Blood	Overall health- no specific illness	Raw
<b>Insects</b>							
<i>Apis mellifera</i>	Apidae	Honey bee/Nyaa	---	0.034	Honey	Cough	Raw
<i>Apis cerana</i>	Apidae	Honey bee/Nyaa	---	0.034	Honey	Cough	Raw

\*CR- Critically Endangered, EN-Endangered, VU-Vulnerable, LC-Least Concern

medicinal plants, such as *Clerodendrum venosum*, *Solanum aethiopicum*, and *Solanum indicum*, were boiled and consumed as vegetables, while the dried leaves of *Goniothalamus* sp. were reduced to ash and applied to the abdomen to alleviate stomach pain.

### Ethnobotanical quantitative indices

#### Informant consensus factor (ICF)

Interviews with 204 individuals yielded a total of 4800 use reports. ICF analysis revealed high knowledge homogeneity (ICF = 1.00) for medicinal plants used to treat typhoid fever, common cold and cough, dental issues, and general illnesses Table 5. Conversely, the lowest homogeneity or maximum heterogeneity (ICF = 0.97) was observed for the use of disinfectants.

#### Use value (UV)

As shown in Table 3, the Use Value (UV) of each medicinal plant was determined to assess the

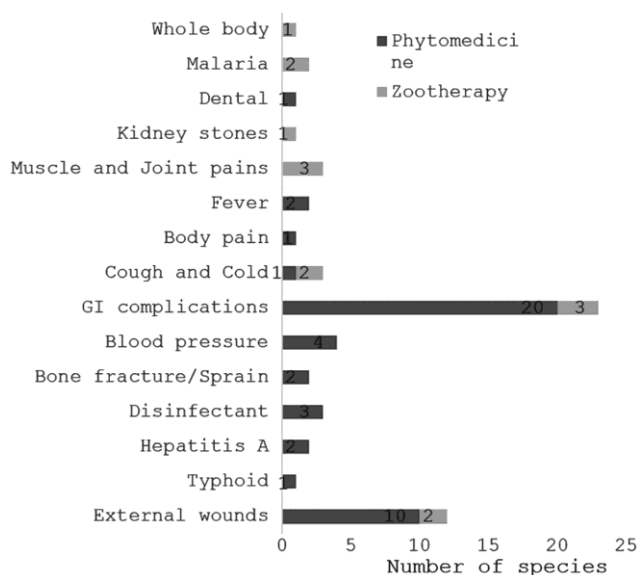


Fig. 5 — Ethnomedicinal treatments for various ailments

Table 5 — Informant Consensus Factor (ICF) values of the medicinal plant species distributed in the study area

Use category	Use citations	No. of species used	ICF
External wounds (Cut wounds, blood coagulant Thorn pricks, Burns)	1247	9	0.99
Typhoid	40	1	1.00
Hepatitis A	53	2	0.98
Disinfectant	65	3	0.97
Bone fracture/Sprain	70	2	0.99
GI complications	1762	17	0.99
Fever (Cough and cold)	562	3	1.00
Dental	169	1	1.00
General (Blood pressure, Body pain)	832	5	1.00

commonness in use of each plant in the study area. The UV index revealed *Artemisia* sp., *Solanum aethiopicum*, *Solanum indicum*, *Centella asiatica*, *Zanthoxylum armatum*, *Curcuma longa*, *Goniothalamus* sp, *Terminalia chebula* having a high UV score of 2.00 Table 3 suggesting that these species are commonly used, and their medicinal knowledge is widespread within the tribe.

#### Family use value (FUV)

The highest FUV Table 3 was recorded for the families Apiaceae (2.00), Annonaceae (2.00), and Combretaceae (2). However, these high FUVs were observed despite these families not being particularly species-rich, demonstrating that FUV is not directly correlated with the number of species in a family<sup>41</sup>. Other families exhibiting relatively high FUVs in the same study included Solanaceae (1.88), Rutaceae (1.67), Zingiberaceae (1.50), and Asteraceae (1.20), each represented by two to five species.

#### Relative frequency citation (RFC)

Analysis revealed that *Ageratum conyzoides*, *Artemisia* sp., *Chromolaena odorata*, *Mikania scandens*, *Oxalis corniculata*, *Solanum aethiopicum*, *Solanum indicum*, *Centella asiatica*, *Citrus medica*, *Zanthoxylum armatum*, *Zanthoxylum rhetsa*, *Clerodendrum venosum*, *Curcuma longa*, *Zingiber officinale*, *Embllica officinalis*, *Goniothalamus* sp., *Hydrocotyle sibthorpioides*, *Musa paradisiaca*, and *Potentilla indica* exhibited the highest RFC values (1.00) Table 3, indicating the most frequent citations by respondents.

#### Zootherapy

The study on the Nocte people's traditional zootherapeutic practices revealed the use of 11 animal species Table 4, comprising 64% mammals, 18% insects, and 9% each of birds and fish. Animal fats were the most utilized component (4 species), primarily for treating external injuries like lacerations Figure 4. Specifically, fats from *Panthera tigris*, *Neofelis nebulosa*, and *Panthera pardus* were used as massage oils for musculoskeletal pain. The lactating mammary gland of the female tiger was considered a valuable commodity, used as a moisturizer for cracked heels and hypertrophic scars, and occasionally kept in homes for purported talismanic purposes.

Most animal products were used fresh or preserved by smoking. Smoked and dried gall bladders (*Ursus thibetanus*) and stomach/intestines (*Hystrix brachyura*) were prepared by boiling small pieces in

water for the treatment of malaria and gastrointestinal issues. Interestingly, the fresh blood of *Mastacembelus armatus* was consumed exclusively by the hunter immediately upon capture. The use of pangolin scales for stomach ailments represents a more recent practice observed in Muktowa village.

The highest relative frequency of citation (RFC) values (0.034) Table 4 were calculated for *Hystrix brachyura*, *Apis mellifera*, and *Apis cerana* in zootherapy, suggesting a lower reliance on animal-derived medicines compared to readily available plant-based remedies.

## Discussion

This study provides valuable ethnopharmacological insights into the traditional medicinal practices of the Nocte tribe, documenting their utilization of both plant and animal resources for healthcare. The rich diversity of documented medicinal plants (34 species from 22 families) and animals (11 species from 8 families) emphasises the extensive knowledge of local flora and fauna within the community. This practice aligned with the broader trend of indigenous communities utilizing nearby biodiversity for health and wellness, highlighting their role as expert bioresource managers<sup>35</sup>. The predominant use of these plants for gastrointestinal issues (45%) reflected a broader trend observed in traditional medicine, where local health concerns shape the medicinal flora utilized by indigenous populations<sup>32</sup>. This trend is evident in the ethnobotanical practices of the Nocte and other tribal groups in Arunachal Pradesh, where plants such as *Alstonia scholaris*, *Andrographis paniculata*, *Begonia roxburghii*, and *Centella asiatica* are commonly utilized to address stomach ailments, including indigestion, dysentery, and stomachache<sup>27,32,35,42</sup>. The application of ethnobotanical quantitative indices provides further depth to the findings. The high ICF values for several common ailments suggest a strong consensus within the community regarding the use of specific plants for these conditions, indicating a well-established and shared body of knowledge. High UV scores for certain plants like *Artemisia* sp., *Solanum* sp., and *Centella asiatica* point to their widespread use and recognition as valuable medicinal resources. The FUV analysis reveals the importance of certain families, even if they are not the most species-rich, highlighting the significance of specific species within those families. The high RFC values for a range

of plants confirm their frequent citation by informants, reinforcing their importance in Nocte traditional medicine.

The preparation methods employed by the Noctes, such as crushing leaves to create pastes for external wounds or boiling plants for consumption, are consistent with traditional practices documented globally. These methods not only served therapeutic purposes but also strengthened cultural practices surrounding food and medicine<sup>27</sup>. Use of specific plants like *Clerodendrum venosum* and *Solanum aethiopicum* for both food and medicine illustrated the multi functionality of these resources, which is a common feature of ethnobotanical knowledge systems. Plants used for blood coagulation and other systemic conditions demonstrated a sophisticated understanding of their pharmacological properties. In addition to plant-based remedies, the Noctes utilisation of animal species in their therapeutic practices highlights a crucial, often overlooked aspect of traditional medicine. Studies have shown that indigenous knowledge of zootherapy is vital for primary healthcare in many communities. Approximately 60-90% of rural populations in developing countries rely on such practices<sup>43</sup>. The consumption of animal parts, such as the gall bladder of *Ursus thibetanus* for malaria treatment, highlights a unique aspect of Nocte healthcare that parallels findings from other tribal communities like the Tangsa and the Wancho<sup>26</sup> where animal-derived remedies are integral to health management.

Overall, this study provides a comprehensive overview of the traditional medicinal practices of the Nocte tribe, highlighting their rich knowledge of both plant and animal resources. The quantitative indices add merit to the findings, providing a deeper understanding of the relative importance and cultural significance of different species. The study also raises important considerations regarding conservation, particularly concerning the use of endangered species like tigers and pangolins. While the use of tigers and leopards for medicinal purposes is an age-old tradition, fats were used to be collected from naturally dead tigers, as the hunting or killing of the species is considered taboo within the tribe. Protecting these big cats is imperative; as apex predators, they play a crucial role in controlling prey populations, sustaining ecosystem health, supporting biodiversity, and providing vital ecological services. The use of Pangolin scales is relatively new, and their usage was

specifically identified in Muktowa village within the Dadam Circle. This emerging knowledge and usage are linked to the cross-border trades with the adjacent villages of Myanmar, caused by border fluidity. It is, however, important to note that the Chinese Pangolin, a critically endangered species, plays a crucial ecological role by serving as a natural regulator of social insect populations, such as ants and termites, thereby influencing local ecosystem functions, including trophic interactions, decomposition, and nutrient cycling<sup>44</sup>. They also help in soil aeration and mineralization by burrowing, which benefits overall soil health and ecosystem stability<sup>45</sup>.

Further extensive research is required to study the phytochemical properties of the documented medicinal plants and the efficacy of the zootherapeutic practices, which could provide valuable insights for drug discovery and development in national healthcare systems while also contributing to the preservation of traditional knowledge of the Indigenous Nocte tribe for future generations to revitalize interest in traditional medicine and safeguard this invaluable cultural heritage.

### Conclusion

This study documents the rich ethnobiological knowledge and traditions of the Nocte tribe, highlighting their traditional medicine systems and their potential integration into modern healthcare. The availability of traditional medicines was especially found advantageous in the region, as the availability of modern healthcare facilities scaled from scarce to none. Furthermore, medical transportation is extremely infeasible due to inaccessible roads, making traditional medicines an essential resource for primary and emergency treatments. Obtaining these forest resources has been found simpler and safer while conducting immediate care. However, to effectively utilise these benefits, further study is required to scientifically validate the effectiveness and safety of these customary remedies. Well-designed clinical trials are important in establishing safe and effective dosages for various ailments. Additionally, ensuring the sustainable harvesting of medicinal plants is important. This involves educating Indigenous communities about sustainable harvesting practices and promoting the cultivation of medicinal plants. However, the primary concern within the Indigenous medicine systems is the use of faunal species classified under the rare, endangered,

threatened (RET) category, which are experiencing a gradual decline. To address this issue, it is necessary to provide the locals with adequate access to modern medicine and raise awareness about the conservation of faunal species. This integrated strategy will contribute to safeguarding both biodiversity and cultural heritage while possibly leading to the development of new therapeutic strategies.

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### Conflict of Interest

The authors declare no conflict of interest.

### Author Contributions

M.T. contributed to the research conceptualization, data gathering, data analysis, and interpretation, and drafted the manuscript. A.M. contributed to organizing and editing the manuscript. K.B. contributed to reviewing and editing the manuscript. All the authors read and approved the final manuscript.

### Ethics Approval

The questionnaire survey was approved and authorized through the Research Ethics Committee of the Amity Institute of Forestry & Wildlife, Amity University, Noida (AUUP/AIFW/REC/2021/07).

### Prior Informed Consent

Verbal consent was obtained after explaining the objectives and implications of the study from each respondent who voluntarily agreed to the survey.

### Data Availability

Data would be made available from the concerned authors on request.

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