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IN-SILICO VALIDATION AND PHARMACOLOGICAL ACTIVITY OF POTENT ANTI VIRAL AND ANTI INFLAMMATORY ETHNO MEDICINAL PLANTS USED BY TRADITIONAL HERBALISTS WITHIN THORANGTLANG WILDLIFE SANCTUARY, MIZORAM, NORTH-EAST INDIA

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ABSTRACT: Background: Our study aims to document the use of ethnomedicinal plants reported by herbalists in treating ailments that are becoming more prevalent. Using an ethnobotanical approach and *in-silico* studies, will advise further prevalence and give precedence to future pharmacological studies. **Methods:** The application of the plants was reported by 75 informants. From the 51 reported plants, 20 plants were frequently cited as having high potential anti viral and anti-inflammatory activity and were validated in *in-silico* approach. PASS was used for compound prediction, and AMT was calculated with the help of ADMET lab 2.0. **Results:** Out of the 20 plants validated in *in-silico*, the results of reported compounds revealed that *Aeginetia indica* could best act as an antiviral agent with Pa (0.939) and Pi (0.003), followed by *Bacopa monnieri* with Pa (0.880) and Pi (0.002) and *Blumea balsamifera* with Pa (0.743) and Pi (0.004). Subsequently, the plant which can act as the best anti-inflammatory ailment is *Andrographis paniculata* with Pa (0.845) and Pi (0.005), followed by *Pisum sativum* with Pa (0.749) and Pi (0.010) and *Blumea balsamifera*with Pa (0.728) and Pi (0.013). Also, the plant which constitutes both potential is *Blumea balsamifera*. **Conclusion:** The pharmaceutical innovation could be useful to validate medicinal plants to treat a wide range of ailments, as well as to actively promote natural medicine and the discovery of novel medicines.

INTRODUCTION: Over the past several decades, the medical knowledge of indigenous peoples evolved by cultures in the way of using herbal medicines has been useful in the contribution of potent therapeutic bioactive materials and pharmaceuticals.

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Substantiated and consequential scientific investigations into the use of ethnomedicinal plants meet the demand for novel, efficient and productive drugs for future research and use [1]. Through the application of traditional knowledge, a wide range of disease prevention and control measures to meet the well-being of people are available.

The Vedas documented potential scenarios for using ethnomedicinal plants between 4500 and 600 B. C. Whether or not the information is accessible; indigenous traditional medicine is the knowledge and practices applied to diagnosing, preventing, or eliminating physical, mental and social diseases.

This knowledge or practice may be based solely on previous experience and observation passed down orally or in writing from generation to generation. These strategies are indigenous to the country in which they are practiced. 88% of the member states corresponding to 170 acknowledge their use of traditional and complementary medicines; global report by the World Health Organization (2019) [2]. From ancient propaganda to direct experimental records, the authentication of ethno-medicinal uses is crucial to human well-being.

The *in-silico* approach will assist in evaluating synthetic compounds' coupling attitude, and the aspiration has become increasingly detailed and specific. Furthermore, the quick explication of complicated connections between substances and different activity targets has been made possible by the advent of network pharmacology technology [3]. With the advancements in computer science and technology, the discovery of new drugs has become more persistent, such as Dozamide, Imatinib, Dasatinib, and Ponatinib, approved by the FDA in 1995, 2001, 2006, and 2012, respectively [4]. In India, the impact of traditional remedies from many ancient systems has a significant impact on communal health and is intimately linked to traditions [5]. Natural chemicals can serve as lead compounds, allowing for the rational creation of new medications, the development of self-assembling synthesis, and the discovery of novel therapeutic qualities not previously assigned to known compounds [6].

Presently, *in-silico* studies are one of the most important research areas with the potential to anticipate the drug-protein interaction, which relates to the mechanism of action of a bioactive molecule derived mostly from traditional medicinal plants [7]. The importance of molecular features that determine absorption, distribution, metabolism, excretion, and toxicity (ADMET), as well as therapeutic potency, are identified as essential factors in determining whether a molecule can be developed successfully as a drug [8, 9, 10]. Also, the Lipinski rule of 5 is used to investigate the type of molecule in *in-silico* for screening at a high potential [11]. These application methods assess permission to use based on numerous assumptions, and they play a significant role in the subsequent selection of biometric analysis of a medicinal plant to cure a certain condition based on the data collected.

MATERIALS AND METHODS:

Study Area: Mizoram consists of two National Parks and eight Wildlife Sanctuaries, which comprise a total of 1728.75 sq. kms., i.e., 8% of the state's total geographical area. Thorangtlang Wildlife Sanctuary is located approximately 245 kilometers south of Aizawl, Mizoram's state capital, between 23°17'20" - 23°11'30" North and 92°30'35" - 92°37'12" East, with the highest elevation falling in Lunglei District **Fig. 1**. The final notification vide was issued by the Government Wildlife Sanctuary in 2002 (No.B. 12012/171/2001-FST of 23.04.2002) covering an area of 180 sq kms. The Sanctuary was surrounded by seven fringing villages: Thenhlum, Laisawral, Sesawm, West Bunghmun, Tleu, West Phulpui, Hruiduk, Dengsur, and Changpui. It has both evergreen and semi-evergreen forests, and its wildlife diversity is the most distinguishing feature of the current study site when compared to other wildlife refuges in Mizoram's forest. The area is mostly rural, and the majority of the residents are uneducated and lack access to modern health care. As a result, the locals depend solely on the region's herbal remedies for healthcare and supplement their meager earnings. So, using traditional remedies to treat individuals is still prevalent in this modern era.

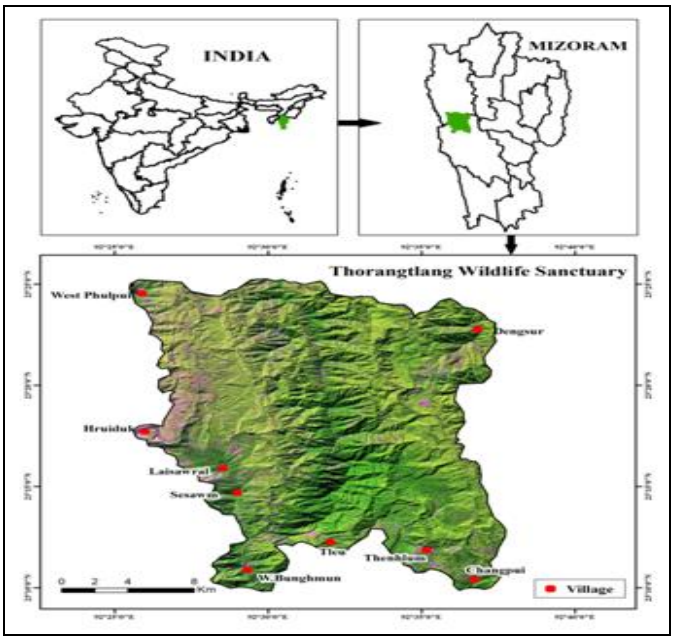


FIG. 1: MAP OF THE STUDY AREA

Data Collection: A field survey was undertaken in the research region, and traditional herbalists were randomly interviewed after verbally being asked about their utilization of ethnobotanical plants. The practice of herbal remedies includes a wide variety of medicinal formulas made from natural substances.

They have thorough experience with the medicinal and nutritional uses of plants and herbs. Among the Mizo people who live in the study area, traditional medical procedures include the use of botanicals in the form of freshly prepared juice, decoction, powdered medicine for oral consumption, and a paste for topical application on skin diseases and wounds. A total of 51 medicinal plants were recorded for distinct ailments by interrogating 75 informants. The Mizo language was used to document their knowledge of medicinal herbs.

Identification of Species: Plants were identified using relevant literature, and the processed specimens were mounted on herbarium sheets according to conventional techniques for further authentication.

***In-silico* Validation and Pharmacological Activity:** An *in-silico* clinical tests are progressively becoming a common practice in the development of medicinal treatments. The present study reveals *in-silico* validation of bioactive compounds which correspond to Antiviral and Anti-inflammatory mechanisms using Biological Spectrum Analysis (PASS) recorded by herbalists to prove the efficacy and activity of such medicinal plants selected.

The 20 most common plants with high citations substantiating the ailment potential of antiviral and anti-inflammatory medicinal plants were validated *in-silico* out of the 51 ethnomedicinal plants documented by 75 informants.

AMT Data: Poor pharmacokinetics and toxicity are common causes of late-phase failure in drug development. It is commonly acknowledged that these problems should be addressed promptly. So, the profile of Absorption, Metabolism, and Toxicity from various reported compounds was evaluated using the ADMET lab tool. The structures were obtained from ChemSpider and PubChem.

Ethnomedicinal Data Interpretation: Participatory Rapid Appraisal and semi-structured interview methods were approached to document ethnomedicinal uses and their modes of practice by traditional healers and herbalists. The collected data was systematized in Microsoft Excel, which resulted in the interpretation of quantitative ethnomedicinal indices. From the data obtained from traditional healers and herbalists, the mode of consumption and administration route was recorded and the ailment categories were grouped into 9 distinct groups. Quantitative ethnomedicinal indices such as the Informant consensus factor, Fidelity level, Frequency citation, Relative Frequency Citation (RFC), and Use Value were used to evaluate the data collected from informants.

Informant Consensus Factor (ICF): The value of ICF was calculated by subtracting the overall number of citations in each category (Nur) from the total plant species used in that particular category (Nt), divided by all citations minus one. To examine the entire usage of plant species as per culture suitability, the Informant Consensus Factor (ICF) was determined. Plants with a high ICF value (when the value proceeds towards 1) are more potent than those with a low ICF value (when the value proceeds towards 0). If most informants acknowledge one or a few plants to treat a particular ailment, the ICF value will be high. The formula calculated it.

$$ICF = Nur\text{-}Nt / Nur\text{-}1$$

Fidelity Level (FL): The fidelity level is the ratio of used citations by informants for the treatment of a particular ailment (Np) with the number of informants who cited the same plant for treating a particular ailment (N). Ailments were divided into distinct categories before computing the fidelity level. The fidelity level was evaluated to identify medicinally relevant plant species in the research area. A significant or high ratio suggests that the optimal plant species are widely used in the research area to treat a certain ailment. The formula was used to determine the level of fidelity.

$$FL\% = Np / N \times 100$$

Frequency Citation (FC) and Relative Frequency Citation (RFC): Frequency Citation (FC) stated that the total number of informants

interviewed concentrating on the use of a specific plant for a particular ailment. FC was calculated by number of times a particular species was referenced with total number of times that all species were stated. FC was calculated by the formula

FC = (The frequency of a particular species was mentioned) / (The frequency of all species was mentioned) × 100

RFC = (Frequency of citation) / (Total no of informants)

Use Value (UV): The Use Value (UV) indicates plants that are prevalent in the study area. The ratio of the number of user reports for a certain plant species (UR) divided by the overall number of informants interviewed (N) gives the use value (UV). The formula can calculate UV

$$UV = \sum UR/N$$

RESULTS AND DISCUSSION:

Spatial Representation on Descriptive Studies of Reported Ethnomedicinal Data: Ethnomedicinal use of various plant species was collected from 75 informants, of which 54 were male, and the rest were female, with varying age groups between 31 and 80 years **Table 1**. The collected data was analyzed for ethnomedicinal purposes and thus corresponded to 33 biomedical symptoms, further classified into 9 major ailment categories **Table 2**. Among the listed ailment categories, antiviral had the largest number of citations (505 citations and ICF 0.93) followed by anti-inflammatory (440 citations and ICF 0.92), gastrointestinal disease (GIT) (102 citations and ICF 0.9), Circulatory system ailments (39 citations and ICF 0.86), skeletal disorders (30 citations and ICF 0.89), otorrhea (23 citations and ICF 0.9), kidney disease (16 citations and ICF 0.86), eye ailments (12 citations and ICF 0.72) and liver disease (10 citations and ICF 0.8) **Table 4**. Among the entire list of ailment categories, antiviral (42.9%) and anti-inflammatory (37.4%) were the most cited **Fig. 3**. A list of 51 medicinal plants was recorded for distinct ailments through an interrogation with their mode of preparation **Table 3**. **Fig. 2** shows the percentage usage of various plant parts. Among various plant parts used and recorded, leaves showed the highest (39%), followed by bark (16%), and root (13.4%). Stem (10%), whole plant (6%), fruit (6%), flower (4%), rhizome (3%) and seed (1%).

In the present study, the mode of administration is in various forms: juice, paste, cooked, decoction, powder, and raw. As shown in **Fig. 4**, the highest percentage of consumption is in the form of juice (30.71%), followed by decoction (18.57%), cooked (17.14%), paste (15.71%), powder (9.28%), and raw (8.57). **Fig. 5** represents the percentage of the top ten families reported for ethnomedicinal plants. Out of 51 plants recorded, 20 with the highest number of citations were validated in an *in-silico* approach using the predicted bioactive compounds present in each plant **Table 6**. Also, research on reported pharmacological activity from other sources was recorded using relevant literature **Table 5.**

TABLE 1: DEMOGRAPHIC REPRESENTATION OF INFORMANTS IN THORANGTLANG WILDLIFE SANCTUARY, INDIA

Sl. no.	Age Groups	Herbalists	Male	Female
1	31-40	9	7	2
2	41-50	15	12	3
3	51-60	30	21	9
4	61-70	16	10	6
5	71-80	5	4	1

TABLE 2: CORRESPONDING AILMENT CATEGORIES

Sl. no.	Ailment categories
1	Antiviral: Antiviral, Sore throat, Asthma, Dry cough, Tuberculosis, Bronchitis, Pneumonia, Tonsillitis, Common cold, Viral disease, Influenza, Chickenpox, Respiratory analeptic, mumps.
2	Kidney disorder: Urinary tract infections, Kidney problems
3	Anti-inflammatory: Skin disease, Antiseptic, wounds, herpes, scabies, pimples, cracked/ dry skin (xerosis), Inflammation, rashes, burns, sprains, black water fever, affections of gums and teeth, malarial fever, itches, insect bites, swellings, hyperpyrexia
4	Liver disease: Jaundice
5	Skeletal disorder: Fractured bones, rheumatism, sciatica
6	GIT diseases: Indigestion, Stomach ulcer, peptic ulcer, stomached, diarrhea, dysentery, abdominal colic, chronic

	ulcer
7	Eye ailment: Eye disease
8	Circulatory System ailments: Haemostatic, heart disease, hypertension, blood purifier, beriberi, blood sugar
9	Otorrhea: Ear infection

TABLE 3: ETHNO MEDICINAL PLANTS USED BY INFORMANTS BELONGING TO THORANGTLANG WILDLIFE SANCTUARY

Sl. no.	Botanical name/ Family	Vernacular name	Parts used	Mode of preparation	Treated ailments	Scored citation	UV	FC	RFC
1	*Acacia pennata* (L.) Willd. Fabaceae	Khanghu	R	Juice Decoction	Bronchitis (12), Asthma (13), indigestion (21)	46	0.61	61	0.81
2	*Achyranthes aspera* L. Amaranthaceae	Uihlo	L	Juice Decoction	Anti-viral (30), Anti-inflammatory (17)	47	0.62	62	0.83
3	*Aeginetia indica* L. Orobanchaceae	Sangharvaibel	R	Powder Paste	Anti- viral (51)	51	0.68	68	0.91
4	*Aganope thyrsiflora* (Benth.) Polhill Fabaceae	Hulhu	B	Powder Paste	Fracture bone (17)	17	0.22	22	0.29
5	*Aglaomorphacoronans* (Wall. Ex Mett.) Copel Polypodiaceae	Tuaibur	Rhz	Juice Decoction	Stomach and tooth problem (8), herpes (4)	13	0.17	17	0.22
6	*Albizia chinensis* (Osbeck) Merr. Fabaceae	Vang	B	Paste Powder	Scabies (6) and skin diseases (5)	11	0.14	14	0.19
7	*Alstonia scholaris* (L.) R.Br. Apocynaceae	Thuamriat	B	Decoction Cooked Juice	Malarial fever (4), diarrhea (4), otorrhea (14), antiviral (12), heart disease and hypertension(4)	38	0.5	50	0.67
8	*Andrographis paniculata* (Burm.f.) Ness Acanthaceae	Hnah-kha-pui	L	Decoction Juice	Dry cough (6), Inflammation (31)	37	0.61	61	0.81
9	*Anogeissus acuminata* (Roxb. ex DC.) Wall. ex Guillem. & Perr. Combretaceae	Zairum	B	Juice Cooked Decoction	Antiseptic (7), haemostatic (1), diarrhea (1) and beriberi (2)	11	0.14	14	0.3
10	*Artocarpus lakoocha* Roxb. Moraceae	Theitat	B	Paste Powder	Wounds (7), pimples (2) and cracked skin or xerosis (3)	12	0.16	16	0.21
11	*Bacopa monnieri*(L.) Wettst. Plantaginaceae	Unnamed	WP	Paste Cooked	Inflammation (10), Hyperpyrexa (2), skin disease (5), antiviral (31)	48	0.64	64	0.85
12	*Bischofia javanica* Blume Phyllanthaceae	Khuangthli	L	Paste Decoction Juice Cooked	Wounds (7), sore throat (2) and tonsillitis (2)	11	0.17	17	0.22
13	*Blumea balsamifera* (L.)	Buarthau	L	Juice	Asthma (16),	46	0.61	61	0.81

	DC. Asteraceae			Paste	Stomach Ulcer 20), Tuberculosis (5), liver problem (5)				
14	*Bombax insigne* Wall. Malvaceae	Pang	B	Juice Cooked Decoction	Tonsillitis (6), throat infections (4)	10	0.13	13	0.17
15	*Callicarpa arborea* Roxb. Lamiaceae	Hnahkiah	B L	Juice Powder Paste	Haemostatic (4)and abdominalcolic (5)	9	0.12	12	0.16
16	*Canarium strictum* Roxb. Burseraceae	Unnamed	B	Powder Paste	Rashes (8)	8	0.1	10	0.13
17	*Centella asiatica* (L.) Urb. Apiaceae	Lambak	L R	Raw Juice Cooked	Diarrhea (4), beriberi (2), dysentery (3), peptic ulcers (6), hypertension (7), dry coughs (4), blood purifier (3)	29	0.38	38	0.51
18	*Cheilocostus speciosus* (J. Koenig) C.D. Specht Costaceae	Sumbul	Rhz	Juice Cooked Decoction	Kidney (4), Common cold (3), UTI (5), Eye (2)	14	0.18	18	0.24
19	*Chromolaena odorata* (L.) R.M. King & H. Rob. Asteraceae	Tlangsam	L	Paste Cooked Juice Decoction	Antiseptic (4), blood sugar (5), hypertension (4), purification of blood (6)	19	0.25	25	0.33
20	*Cinnamomum glanduliferum* (Wall.) Meisn. Lauraceae	Khiangzo	Fr L	Raw Cooked Juice	Cough(3), bronchitis (3) and pneumonia (4)	10	0.13	13	0.17
21	*Clerodendrum infortunatum* L. Lamiaceae	Phuihnamchhia	R L	Paste Cooked Juice Decoction	Scabies (5), inflammation (3), skin diseases (3)	11	0.14	14	0.19
22	*Curcuma longa* L. Zingiberaceae	Aieng	WP	Raw Powder Juice Decoction	Asthma (9), Bronchitis (5), Blood purifier (2), inflammation (24)	40	0.53	53	0.71
23	*Dinochloacompactiflora* (Kurz) McClure Poaceae	Sairil	S	Juice Raw	Influenza (6)	6	0.08	8	0.11
24	*Emblica officinalis* Gaertn. Phyllanthaceae	Sunhlu	Fr S	Raw Juice Cooked	Respiratory analeptic (8), Inflammation (28)	36	0.49	49	0.65
25	*Flueggea virosa* (Roxb. Ex Willd.)Royle Euphorbiaceae	Saisiak	L	Cooked Juice	Chicken pox (7)	7	0.09	9	0.12
26	*Garuga pinnata* Roxb. Burseraceae	Bung-bu-tuai-ram	L S	Cooked Juice	Asthma (14), inflammation	38	0.5	50	0.67

				Decoction	(24)				
27	*Gmelina arborea* (Roxb.) Lamiaceae	Thlanvawng	L	Cooked Juice Decoction	Coughs (3), snakebites (2), itching skin (6)	11	0.14	14	0.19
28	*Hiptage benghalensis* (L.) Kurz Malpighiaceae	Raisentur	L S	Cooked Juice Decoction	Cough (12), asthma (10), diarrhea (3), ulcer (20)	45	0.6	60	0.8
29	*Ipomoea aquatic* Forssk. Convolvulaceae	Kuangkua	L S	Cooked Juice Decoction	Bronchitis (23), malarial fever (12), jaundice (5)	40	0.53	53	0.71
30	*Lindernia ruellioides* (Colsm.) Pennell Linderniaceae	Thasuih	WP	Cooked Juice Raw Decoction	Rheumatism (2), sciatica (3), skin worms (2), wounds (5), eye problems (3), kidney problem (2)	17	0.22	22	0.29
31	*Lobelia nummularia* Lam. Campanulaceae	Choakathi	L	Juice Cooked Decoction	Eye infections (3), peptic ulcers (6), dysentery (4), tonsillitis (3),throat pain (4)	20	0.26	26	0.35
32	*Magnolia champaca* (L.) Baill.ex Pierre Magnoliaceae	Ngiau	Fl L	Cooked Juice Decoction	kidney disorders (5), eyes to improve vision (4), cough (4)	13	0.17	17	0.23
33	*Mikania micrantha* Kunth Asteraceae	Japanhlo	L	Raw Paste Juice	antiseptic in cuts and wounds (6), diarrhea (2), dysentery (4), fever and malaria (4), ear pain (2)	18	0.24	24	0.32
34	*Millettia pachycarpa* Benth. Fabaceae	Rulei	R	Cooked Juice Decoction	Wounds (7), swellings (4), toothache (2), sprains (2), itches (3)	18	0.24	24	0.32
35	*Mussaenda macrophylla* Wall. Rubiaceae	Vakep	L R	Juice Raw Paste	Coughs (4), chronic or obstinate ulcer (1), snake bites (2)	7	0.09	9	0.12
36	*Ocimum sanctum* L. Lamiaceae	Unnamed	L	Paste Decoction Juice	Asthma (9), Inflammation (20), viral disease (10)	39	0.52	52	0,69
37	*Pajanelia longifolia* (Willd.) K. Schum Bignoniaceae	Ram archangkawm	L S	Juice Paste	Fractured bone (2)	2	0.02	2	0.02
38	*Piper betle* L. Piperaceae	Panruang	L	Juice Cooked	Sore throat (27), Affections of gums and teeth	43	0.57	57	0.76

					(16)				
39	*Piper longum* L. Piperaceae	Thing hmarcha	Fl	Powder Raw Decoction	Asthma (10), bronchitis (9), Inflammation (16)	35	0.46	46	0.61
40	*Pisum sativum* L. Fabaceae	Motor chana	S	Raw Decoction Juice	Bronchitis (10), burns (24)	34	0.45	45	0.6
41	*Pueraria tuberosa (*Willd.) DC. Fabaceae	Zawng tur	L	Juice Cooked Decoction	Cough (23), Malarial fever (20)	43	0.57	57	0.76
42	*Sapindusmukorossi*Gaertn. Sapindaceae	Hlingsi	Fr	Juice Powder Paste	Mumps (4), cough (3) and tonsillitis (5)	12	0.16	16	0.21
43	*SchimawallichiiChoisy* Theaceae	Khiang	Fr B	Juice Powder Paste	Insect bites (7), antiseptic (2), snake bites (4)	13	0.17	17	0.23
44	*Solanum xanthocarpum* Schrad. & H. Wendl. Solanaceae	Athlohling	Seed	Raw Paste Powder	Toothache (5)	5	0.06	6	0.08
45	*Spilanthesacmella* (L.) L. Asteraceae	Ankasate	L Fl	Juice Paste	Affections of throat (32) and gums (10)	42	0.56	56	0.74
46	*Tetramelesnudiflora* R.Br. Tetramelaceae	Thing dawl	B L	Juice Powder Paste	Otorrhea (Ear infection) (7)	7	0.09	9	0.12
47	*Thunbergia alata*Bojer ex Sims Acanthaceae	Vako	L	Juice	Sore throat (9), wounds (18), asthma (7)	34	0.45	45	0.6
48	*Uncaria laevigata* Wall. ex G. Don. Rubiaceae	Ralsamkuai	R	Juice Cooked Decoction	Tonsillitis (3), herpes (4)	7	0.09	9	0.12
49	*Vitex peduncularis* Wall. ex Schauer Lamiaceae	Thingkhawilu	L R B	Cooked Juice Decoction	Malaria (3), black-water-fever (2), coughing (1)	6	0.08	8	0.11
50	*Vitis latifolia* Roxb. Vitaceae	Vawm-hrui	R	Raw Paste Juice	Swellings (3) and sciatica (6)	9	0.12	12	0.16
51	*Zingiber officinale* Roscoe Zingiberaceae	Sawhthing	WP	Juice Paste Cooked	Sore throat (22), Inflammation (19)	41	0.54	54	0.72

TABLE 4: ICF AND FL VALUE OF REPORTED ETHNO MEDICINAL PLANTS

Sl. no.	Ailments	Nur	Nt	ICF	FL
1	Antiviral	505	33	0.93	*Acacia pennata (54), Achyranthes aspera (64) Alstonia scholaris (32) Andrographis paniculata (16) Bischofia javanica (36) Blumea balsamifera (46) Bombax insigne (60) Centella asiatica (7) Cheilocostus speciosus (21) Cinnamomum glanduliferum (100) Curcuma longa (35) Dinochloacom pactiflora (100) Emblica officinalis (22) Flueggea virosa (100) Garuga pinnata (37) Gmelina arborea (26) Hiptage benghalensis (49) Ipomoea aquatica (57) Magnolia champaca (31) Mussaenda macrophylla (58) Ocimum sanctum (49) Piper betle (63) Piper longum(54) Pisum sativum (29) Lobelia nummularia (35) Pueraria tuberosa (54) Sapindus mukorossi (100) Thunbergia alata(47) Uncaria laevigata (43) Zingiber officinale (54) Aeginetia indica (100) Bacopa monnieri (65) Vitex peduncularis (17)*

2	Anti-inflammatory	440	35	0.92	*Achyranthes aspera (36) Aglaomorpha coronans (92) Albizzia chinensis (100) Anogeissus acuminata (64) Artocarpus lakoocha (100) Bacopa monnieri (35) Bischofiajavanica (64) Ipomoea aquatica (30) Canarium strictum (100) Chromolaena odorata (21) Clerodendrum infortunatum (100) Gmelina arborea (74) Lindernia ruellioides (24) Mikania micrantha (55) Millettia pachycarpa (100) Mussaenda macrophylla (27) Piper betle (37) Pisum sativum (71) Pueraria tuberosa (46) Schima wallichii (100) Alstonia scholaris (10) Spilanthes acmella (100) Thunbergia alata (53) Uncaria laevigata (57) Vitex peduncularis (83) Vitis latifolia (33) Zingiber officinale (46) Curcuma longa (60) Ocimum sanctum (51) Garuga pinnata (63) Andrographis paniculata (84) Emblica officinalis (78) Piper longum (46) Bombax insigne (40) Solanum xanthocarpum (100)*
3	Liver disease	10	3	0.8	*Ipomoea aquatica (13) Blumea balsamifera (11) Lindernia ruellioides (11)*
4	Skeletal disorders	30	4	0.89	*Aganope thyrsiflora (100) Lindernia ruellioides (29) Pajanela longifolia (100) Vitis latifolia (67)*
5	GIT Diseases	102	11	0.9	*Aglaomorpha coronans (8) Anogeissus acuminata (18) Blumea balsamifera (43) Callicarpa arborea (55) Centellaasiatica(47) Acacia pennata (46) Hiptage benghalensis (51) Alstonia scholaris (10) Mikania micrantha (34) Mussaenda macrophylla (15) Lobelia nummularia (50)*
6	Circulatory System ailments	39	6	0.86	*Alstonia scholaris (11) Anogeissus acuminata (18) Callicarpa arborea (45) Centella asiatica (46) Chromolaena odorata (79) Curcuma longa (5)*
7	Eye ailments	12	4	0.72	*Cheilocostus speciosus (14) Lindernia ruellioides (18) Magnolia champaca (31) Lobelia nummularia(15)*
8	Otorrhea	23	3	0.9	*Tetrameles nudiflora (100) Alstoniascholaris (37) Mikania micrantha (11)*
9	Kidney disease	16	2	0.86	*Cheilocostusspeciosus (65) Magnolia champaca(38)*

TABLE 5: REPORTED PHARMACOLOGICAL ACTIVITY OF 20 PLANTS

Sl. no.	Botanical Name with family	Vernacular Name	Plant Part used	Mode of Preparation	Ailments treated	Reported Pharmacological Activity from other studies
1.	*Acacia pennata* (L.) Willd. Mimosaceae	Hlonuar	R	Juice, Decoction	Bronchitis, Asthma	Anti-inflammatory, antiviral, anti-nociceptive[12]
2.	*Achyranthes aspera* L. Amaranthaceae	Uihlo	L	Juice, Decoction	Anti-viral, Anti-inflammatory	Wound healing, antiinflammation [13]
3.	*Aeginetia indica* L. Orobanchaceae	Sangharvaibel	R	Powder, Paste	Anti-inflammatory	Inflammation, cough, arthritis, diabetes [14]
4.	*Alstoniascholaris*(L.) R. Br. Apocynaceae	Thuamriathnai	B	Decoction, Cooked, Juice	Asthma, High BP	Anti- inflammatory, antiasmatic, cough[15]
5.	*Andrographis paniculata*(Burm. f.) Nees Acanthaceae	Hnah-kha-pui	L	Decoction, Juice	Dry cough, immune booster	Flu, cold, fever, diabetes, hypertension[16]
6.	*Blumea balsamifera*(L.) DC. Asteraceae	Buarthau	L	Juice, Paste	Asthma, Stomach Ulcer, Tuberculosis	Respiratory system, stomach [17]
7.	*Curcuma longa* L. Zingiberaceae	Aieng	WP	Juice, Paste	Asthma, Bronchitis, Blood purifier	Anti-inflammatory, antiviral, antiseptic, analgesic [18]
8.	*Emblica officinalis* Gaertn. Phyllanthaceae	Sunhlu	B	Decoction, Juice	Respiratory analeptic, food allergy	Antioxidants, Anti-inflammatory[19]
9.	*Garuga pinnata*Roxb. Burseraceae	Bung-bu-tuai-ram	L	Juice	Asthma	Asthma, pulmonary infections [20]
10.	*Bacopa monnieri* (L.) Wettst	Unnamed	WP	Paste, Cooked	Inflammation, Hyperpyrexa,	Antioxidant, anti-inflammatory, memory

	Plantaginaceae				skin disease	enhancement, antidepressant [21]
11.	*Hiptagebenghalensis* (L.) Kurz Malpighiaceae	Raisentur	B,L,Fl	Raw, Paste	Cough, Asthma, diarrhea, Ulcer	Anti- inflammatory, hepatoprotective, antioxidant, asthma [22]
12.	*Ipomoea aquatica*Forssk. Convolvulaceae	Kuangkua	L	Decoction, Juice, Cooked	Bronchitis, High fever, Jaundice	Anti-inflammation, bronchitis, leucoderma, antihelmintic [23]
13.	*Ocimum sanctum* L. Lamiaceae	Unnamed	L	Paste, Decoction, Juice	Asthma, Immune booster, viral disease	Anti-inflammatory[24]
14.	*Piper betle*L. Piperaceae	Pan ruang	L	Juice, Cooked	Sore throat, Affections of gums and teeth	Antibacterial [25]
15.	*Piper longum* L. Piperaceae	Thing hmarcha	Fl	Powder, Raw, Decoction	spiratory track problems, Asthma, bronchistis	sthmatic, antibronchitis, highcoughs, [26]
16.	*Pisum sativum* L. Fabaceae	Motor chana	S	Raw, Decoction, Juice	Bronchitis, burns, laxative	Anti-hypertension, anti-inflammatory, antiviral[27]
17.	*Pueraria tuberose* (Willd.) DC Fabaceae	Zawng tur	T	Cooked, juice, paste	Cough, Malarial fever	Anti-inflammatory, anti-stress, immunomodulatory, wound healing [28]
18.	*Spilanthesacmella*(L.) L. Asteraceae	Ankasate	L, Fl	Juice, Paste	Affections of throat and gums	Antiviral, diuretic and wound healing [29]
19.	*Thunbergia alata*Bojer ex SimsAcanthaceae	Vako	L	Juice	Sore throat, wounds, asthma	Anti-inflammatory, anti-spasmodic, antiviral [30]
20.	*Zingiber officinale* Roscoe Zingiberaceae	Sawhthing	WP	Juice, Paste, Cooked	Sore throat	Anti-inflammatory, anti-cancer, antiviral, anti-ageing [31]

R- root, L- leaf, B- bark, WP- whole plant, Fl- flower

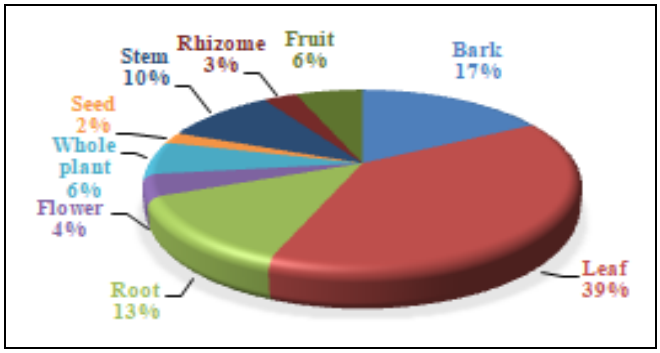


FIG. 2: REPRESENTATION ON SUBSTANTIAL PLANT PART USED OF REPORTED ETHNO MEDICINAL

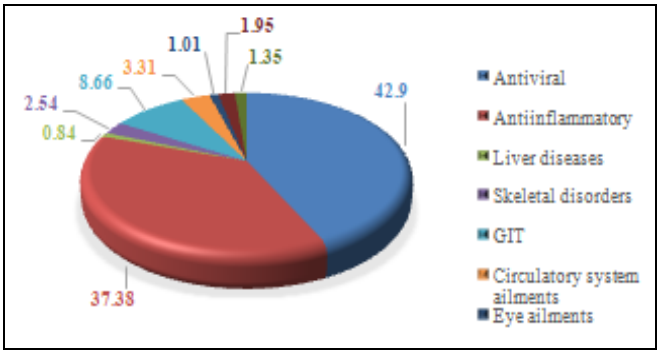


FIG. 3: PERCENTAGE OF REPORTED AILMENTS

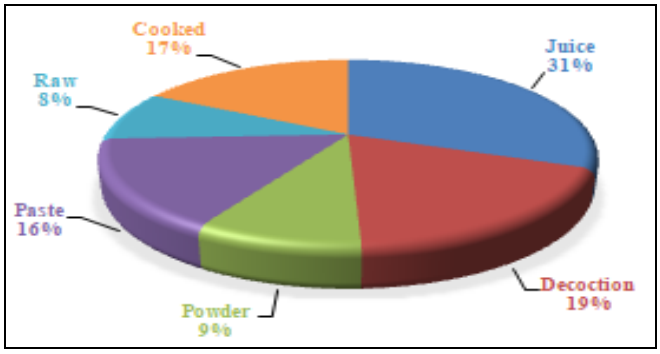


FIG. 4: PERCENTAGES ON MODE OF PREPARATION

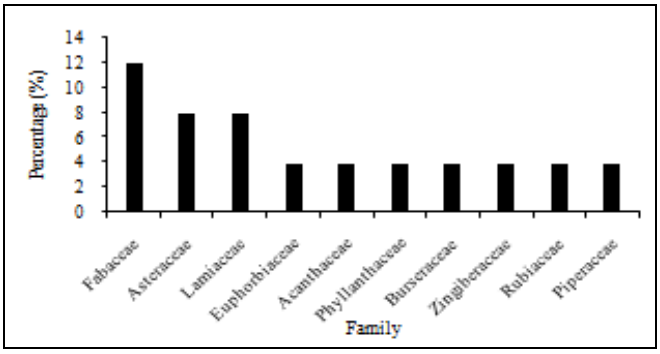
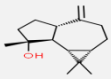
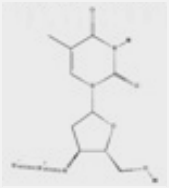
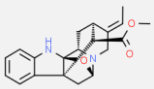
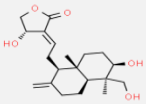
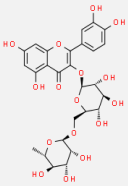
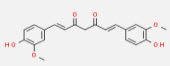
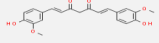
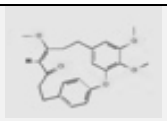
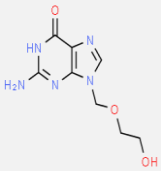
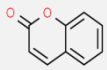
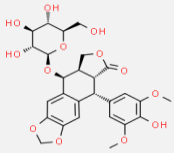
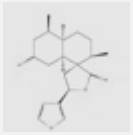
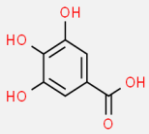
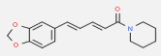
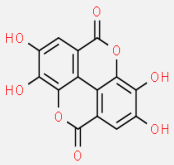
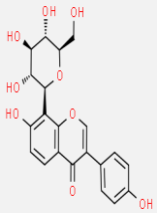
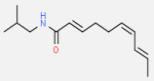
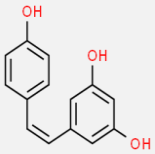
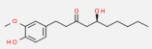


FIG. 5: PERCENTAGE OF REPORTED TOP TEN FAMILIES

TABLE 6: *IN-SILICO* VALIDATION OF BIOACTIVE COMPOUNDS PRESENT IN VARIOUS REPORTED ETHNO-MEDICINAL PLANTS

Sl. no.	Botanical name	Ethnomedicinal uses	Reported compounds	PASS prediction			AMT prediction		
				Predicted bioactivities	Pa	Pi	A	M	T
1	*Acacia pennata* (L.) Willd. Mimosaceae	Bronchitis, Asthma	Tetracosane	Antiviral Anti-inflammatory Antieczematic	0.681 0.585 0.895	0.007 0.004 0.005	+++	+++	++
2	*Achyranthes aspera* L. Amaranthaceae	Anti-viral, Anti-inflammatory	Spathulenol 	Anti-inflammatory Antieczematic Antiviral (Adenovirus)	0.521 0.826 0.262	0.51 0.013 0.125	+++	+++	+
3	*Aeginetia indica* L. Orobanchaceae	Anti- inflammatory	Concanavalin 	Antiviral Antiviral (Poxvirus) Immunostimulant	0.939 0.733 0.506	0.003 0.008 0.036	+++	+++	++
4	*Alstoniascholaris*(L.) R. Br. Apocynaceae	Asthma, High BP	Picrinine 	Antiviral (influenza) Antiviral (Influenza A)	0.338 0.224	0.069 0.153	++	+++	++
5	*Andrographis paniculata*(Burm. f.) Nees Acanthaceae	Antihelmintic, anti-inflammatory, strength promoter	Andrographolide 	Anti-inflammatory Antieczematic Immunosuppressant	0.845 0.875 0.751	0.005 0.007 0.011	+++	+++	+
6	*Blumea balsamifera*(L.) DC. Asteraceae	Asthma, Stomach Ulcer,Tuberculosis	Rutin 	Antiviral (influenza) Antiinflammatory Antiinfective	0.743 0.728 0.657	0.004 0.013 0.009	++	+++	+
7	*Curcuma longa* L. Zingiberaceae	Asthma, Bronchitis, Blood purifier	Curcumin 	Antiinflammatory Antiinflammatory (intestinal) Antiviral	0.677 0.610 0.418	0.019 0.004 0.013	+++	+++	+++
8	*Emblica officinalis* Gaertn. Phyllanthaceae	Respiratory analeptic, food allergy	Curcumin 	Antiinflammatory Antiinflammatory (intestinal) Antieczematic	0.677 0.610 0.623	0.019 0.004 0.076	+++	+++	+++
9	*Garuga pinnata*Roxb.	Asthma	Garuganin III	Antiinflammatory Antiviral	0.662 0.237	0.021 0.052	+++	++	++

	Burseraceae								
10	*Bacopa monnieri* (L.) Wettst. Plantaginaceae	Inflammation, Hyperpyrexa, skin disease	Acyclovir 	Antiviral (pox virus) Antiviral Antiviral (Herpes)	0.880 0.835 0.794	0.002 0.004 0.002	++	+++	++
11	*Hiptagebenghalensis* (L.) Kurz Malpighiaceae	Cough, Asthma, diarrhea, Ulcer	Coumarins 	Antiinflammatory Antiviral	0.615 0.585	0.028 0.008	++	+++	++
12	*Ipomoea aquatica*Forssk. Convolvulaceae	Bronchitis, High fever, Jaundice	Lignan 	Antiviral Antieczematic	0.458 0.664	0.044 0.059	++	++	+
13	*Ocimum sanctum* L. Lamiaceae	Asthma, Immune booster, viral disease	Crotonin (Terpene) 	Anti-inflammatory Antiviral Antieczemmatic	0.487 0.403 0.422	0.061 0.087 0.183	++	+++	+
14	*Piper betle*L. Piperaceae	Sore throat, Affections of gums and teeth	Gallic acid 	Antiinflammatory Antiviral	0.548 0.582	0.044 0.023	++	+++	++
15	*Piper longum* L. Piperaceae	ıtory track problems, asthma, bronchitis	Piperin 	Anti-inflammatory Membrane integrity agonist	0.314 0.916	0.060 0.007	+++	+++	+++
16	*Pisum sativum* L. Fabaceae	Bronchitis, burns, laxative	Ellagic acid 	Anti-inflammatory Respiratory analeptic Membrane integrity agonist	0.749 0.572 0.882	0.010 0.026 0.016	+++	+++	++
17	*Pueraria tuberose* (Willd.) DC. Fabaceae	Cough, Malarial fever	Puerarin	Antiinflammatory Antiviral	0.550 0.579	0.043 0.024	++	++	++

									
18	*Spilanthesacmella*(L.) L. Asteraceae	Affections of throat and gums	Spilanthol 	Antiviral Immunosuppressant Antieczematic	0.550 0.416 0.703	0.032 0.062 0.044	+++	+++	++
19	*Thunbergia alata*Bojer ex Sims Acanthaceae	Sore throat, wounds, asthma	Resveratrol 	Anti-inflammatory Antieczematic Antiinfective	0.554 0.718 0.599	0.042 0.040 0.013	+++	++	+
20	*Zingiber officinale* Roscoe Zingiberaceae	Sore throat	Gingerol 	Antiinflammatory Antiviral (influenza) Immunosuppressant	0.532 0.466 0.363	0.048 0.029 0.049	+++	++	+

A-absorption, M-metabolism and T-toxicity. The scale ranges from low (+), medium (++) and high (+++)

Quantitative Analysis of Ethno-botanical Indices: Reported data from ethnobotanical approaches can be used for inductive reasoning, quantitative validation, and comparative evaluation. One major step taken in the acceptance of quantitative estimation is determining how to generate values that are dependable and commensurate measures of immeasurable subjective data. According to Heinrich plants with a high Informant Consensus Factor (ICF) are useful in selection for further investigation of biologically bioactive compounds present in plants [32]. ICF results showed a high degree of consensus for antiviral (0.93) and anti-inflammatory (0.92), which were followed by gastrointestinal ailments and otorrhea (0.9), skeletal disorders (0.89), circulatory system ailments and kidney disease (0.86), liver disease (0.8) and eye ailments (0.72) **Table 4**. A rising score in ICF implies that these diseases are more pervasive in the study area. The ethnomedicinal plants that traditional herbalists extensively use have higher Fidelity Level (FL) values. The contemporary study indicates 16 ethnomedicinal plants having high FL values *viz*. *Cinnamomum glanduliferum* (Wall.) Meisn. (100%), *Dinochloa compactiflora* (Kurz.) McMclure (100%), *Flueggea virosa* (Roxb. Ex Willd.) (100% FL), *Sapindus mukorossi* Gaertn. (100%), *Aeginetia indica* L. (100%), *Albizzia chinensis* (Osbeck)Merr. (100%), *Artocarpus lakoocha* Roxb. (100%), *Canarium strictum*Roxb. (100%), *Clerodendrum infortunatum* L. (100%), *Millettia pachycarpa* Benth. (100%), *Schima wallichii* Choisy (100%), *Spilanthesac mella* (L.) L. (100% FL), *Solanum xanthocarpum* Schrad & H. Wendl. (100%), *Aganopethyrsiflora* (Benth.) Polhill (100%), *Pajanela longifolia* (Willd.) K. Schum (100%) and *Tetramelesnudiflora* R.Br. (100%).

A frequency citation represents the number of times a specific plant was cited, with a total number of times all species were stated. Out of the 51 ethnomedicinal plants recorded, *Aeginetia indica* L. scored the highest number of citations (51 citations, with 0.91 RFC and a Use value of 0.68) used for anti-viral agents. Use value (UV) indices were used to emphasize the usage priority by traditional herbalists living in Thorangtlang Wildlife Sanctuary.

***In-silico* Validation of Reported Ethnomedicinal Plants:** An *in-silico* validation approach was carried out on the 20 reported ethnomedicinal plants with elevated scores in citations (Frequency Citation), which were used against antiviral and anti-inflammatory ailments. The pharmacological activity of various reported compounds was validated using Biological Spectrum Analysis (PASS). It evaluates the interactions of different bioactive compounds corresponding to each medicinal plant recorded. The key to medicinal plant research and development is a detailed understanding of the active chemicals found in plants. As a result, the collection of constituent data and the creation of a compound database are critical to their implementation. The prediction findings were expressed as percentages of probable activity (Pa) and inactivity (Pi) (ranging from 0.000 to 1.000). As a result, in this study, a higher Pa value (>0.900) and a lower Pi value imply higher activity **Table 6**.

The predicted PASS result of reported compounds revealed that *Aeginetia indica* L. could best act as an antiviral agent with Pa (0.939) and Pi (0.003), followed by *Bacopa monnieri* (L.) Wettst. with Pa (0.880) and Pi (0.002) and *Blumea balsamifera* (L.) DC. with Pa (0.743) and Pi (0.004). Subsequently, the plant which can act as the best anti-inflammatory ailment is *Andrographis paniculata* (Burm.f.) Nees with Pa (0.845) and Pi (0.005) followed by *Pisum sativum* L. with Pa (0.749) and Pi (0.010), and *Blumea balsamifera* (L.) DC. *with Pa* (0.728) and Pi (0.013). Also, the plant which constitutes both antiviral and anti-inflammatory agents is *Blumea balsamifera* (L.) DC.

AMT Prediction: Novel machine learning techniques that can be used for drug development and prediction of these chemical features have received much attention. The calculations were done with a large number of molecules and are a type of multidimensional selection filter. The present study demonstrates data from databases of chemicals with experimentally measured AMT qualities using the ADMET tool. The process of medicine being absorbed into the human circulatory system is known as absorption. The initial substance is transformed into new chemicals termed metabolites during metabolism. Redox enzymes, also known as cytochrome P450 enzymes, are responsible for the bulk of small-molecule drug metabolism in the liver. The initial versions of the drug and its metabolites are excreted from the human body. The toxicity of the drug affects the human body. According to the findings, most of the described compounds can be efficiently digested, absorbed, and transported via the human digestive tract, *viz.,* tetracosane, spathulenol, concanavalin, andrographolide, curcumin, piperin, and spilanthol. The outputs of the toxicological potency demonstrate the carcinogenicity of the reported compounds and some non-mutagenic compounds. The compounds with a less toxicological record are spathulenol, andrographolide, rutin, lignin, crotonin, resveratrol, and gingerol **Table 6**.

CONCLUSION: Traditional use; reviews; clinical investigations; and rigorous, double-blind, placebo-controlled trials are used to support the viability of herbal products in common use. There are few systematic clinical trials to back up claims in most cases. Ethnomedicinal plants, bioactive compounds, and secondary metabolites have a long history of being used in contemporary medicine and some traditional medical systems and are the source of many significant medications. A substantial proof approach to this challenge was just recently executed, and the results show significant gaps in research for most herbal products before one can be assured of their virtue. The safety of some herbal compounds has recently been called into question, in part due to the occurrence of side effects associated with their consumption and, increasingly, due to evidence of clinically suitable interactions between herbs and prescription drugs. The current study discovered specific plant compounds for bioactivities of herbal exposition against antiviral and anti-inflammatory ailments. The goal of improving the utilization of traditional medicinal plants is to identify and forecast the pharmacological basis of their activity. These could be used to assist with pharmaceutical innovation and the exploitation of medicinal plants to alleviate a number of ailments, as well as to popularize the use of natural medicine and for the discovery of novel medicines.

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