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Harnessing traditional knowledge: antiviral medicinal flora of the lower Brahmaputra Valley

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A study was undertaken with objective to document plant species utilizing traditional knowledge within various regions of the Lower Brahmaputra Valley zone of Assam. Data was collected from 46 traditional healers and analysed using Use Value (UV) and Factor of Informant Consensus (F_{ic}). The survey revealed a total of 109 plant species with antiviral properties, encompassing 97 genera and 53 families. Notably, *Azadirachta indica* and *Zingiber officinale* have demonstrated the highest UV values. The F_{ic} value for the hepatic infections is highest having a value of 0.833. Herbal formulations are primarily derived from leaves, and the principal method of administration involves extracting and consuming the juice. The primary application of these formulations is in treating respiratory tract infections. Furthermore, the study highlighted the use of synergistic agents in conjunction with the herbal formulations.

Keywords: Assam, Lower Brahmaputra valley zone, Traditional medicines, Use value, Viral diseases

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Traditional knowledge (TK) is the innovative skills and practices that were developed, sustained, and passed on to generations. It is also related to relationships between human societies and plants. Ethnobotanical surveys help to explore such knowledge, particularly the use of plants for food, medicine, and other cultural practices. For centuries, herbal medicines have played a crucial role in primary healthcare systems worldwide, particularly in indigenous and local communities where access to modern medical facilities may be limited. The development of modern-day pharmacology is also a result of traditional knowledge of medicinal plants, with numerous present-day drugs derived from plant-based bioactive compounds. Hence, the documentation of this knowledge will aid in preserving cultural heritage along with the identification of potential bioactive compounds for future drug discovery[1-3].

Infectious viral diseases pose a significant threat to both human and animal populations, resulting in substantial morbidity, mortality, and associated healthcare costs. The different types of viral diseases found all over India and mainly in Assam are West Nile virus, chikungunya, infections caused by RSV (Respiratory Syncytial Virus), Dengue, measles, viral pneumonia, common cold/rhinitis, chickenpox, flu, viral gastroenteritis, SARS-CoV-2, Japanese encephalitis and many more[4-6]. Additionally, certain viral STIs (sexually transmitted infections) have also been reported. It includes hepatitis, HIV/AIDS (Human Immuno deficiency Virus/Acquired Immunodeficiency Syndrome), cutaneous or mucosal warts arising from HPV (Human Papillomavirus), and HSV (Herpes simplex virus)[7]. Although modern antiviral medicines are available for a group of infections, their effectiveness and accessibility are still limited. This also aided in the considerable importance of the herbal medicines used traditionally to treat viral infections or related symptoms. India, with its large forest cover, possesses an opulent heritage of herbal medicine and ethnobotanical knowledge. The indigenous and rural communities residing mainly across the fringe areas of forests rely extensively on herbal formulations as a remedy for a wide range of ailments. The northeastern region of India is renowned for its vast number of plant species, many of which are used by local people for their daily needs, including food, medicine, and other cultural purposes[8-10].

Traditional knowledge of the utilisation of plants is deeply associated with the lifestyles of these people

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and thereby plays a vital role in primary healthcare. The use of a large variety of plant species in folk medicine as a remedy for various diseases reflects the extensive ethnomedicinal prospect of the region. Assam, being the second-largest state of the northeast of India, is home to a variety of plant species and different ethnic communities. The ethnic communities have continued to maintain the rich traditions of plant-based healing practices. The diverse ecology of the region and long-standing interdependence between the people and natural resources are the main reasons behind the extensive ethnomedicinal knowledge[11]. The state of Assam, comprising a rich floristic diversity, possesses numerous plant species of economic and medicinal importance in particular. Traditional village healers, herbalists, and Ayurvedic medical practitioners frequently utilize medicinal plants in their practices[12]. Approximately 8000 species of plants to date have been known to be used for their medicinal purposes[11]. With the help of this ethnobotanical knowledge, potential medicinal plants can be identified for their effectiveness against particular diseases. Morphological and phytochemical analyses offer the potential to identify promising avenues for the development of pharmaceutical products targeting a diverse array of diseases[6].

The different districts in the Lower Brahmaputra Valley Zone (LVBZ) are characterised by a combination of wetlands, riverine plains, and forested areas. These districts, especially the remote/rural areas, are inhabited by multiple ethnic groups who continue to rely on herbal medicines for treating various ailments. The various districts of LBVZ are composed of diverse ethnic communities such as the Bodo, Rabha, Koch-Rajbongshi, Mishing and Assamese communities. Previous ethnobotanical studies in various districts of Lower Assam have highlighted that certain communities are very well-versed with the traditional use of plants, including the Bodo tribal community residing mainly in the BTAD (Bodoland Territorial Area Districts)[8-10,13-16]. However, despite the rich ethnobotanical heritage of the region, systematic documentation of antiviral medicinal plants used by these communities remains limited. It has been also observed that the application and transmission of traditional knowledge is declining day by day. This is mainly due to the rapid changes in the socio-economic conditions, habitat loss, and over-utilisation of the resources. These have threatened both biological diversity and indigenous healing practices, highlighting the urgent need for meticulous documentation and conservation of these valuable resources. Therefore, this study is carried out with the objective of recording the medicinal plants utilised by ethnic communities within the LBVZ for addressing viral infections. It is hypothesised that the ethnic communities of LBVZ possess diverse traditional knowledge of antiviral medicinal plants.

Materials and Methods

Study area

A comprehensive field survey was executed across various regions within the LBVZ of Assam (Fig. 1)[17], spanning the period from 2022 to 2023. The surveyed area belongs to a total of 31 villages including Tapa, Jashodarpam, Belbari, Betbari, Mahatallhati, Taparttari, Koimari, Sravankata, Muyongpara, Gerukabari, Amguri, Bansbari, Chencharghat, Banekuchi, Baghmara, Barama, Elengamari, Narayanguri, Rupahi, Rangafali, Pub-Howli Tamulpur, Pancharatna, Karbala, Bashbari, Jaraguri, Goladangi, Gokulkata, Dakuapara, Barbila, Deohati, and Dhanbandha.

Sampling

The research employed a purposive sampling technique based on their traditional knowledge of plants used as medicines. Initial informants were identified through consultation with village elders and other community members. These informants were then interviewed using semi-structured questionnaire. A total of 46 key informants were identified having knowledge in traditional healing practices. Efforts were made to include healers from all major communities within the study area to ensure broad representation of local ethnobotanical knowledge.

Data collection and processing

The survey was conducted among healers/informants by taking verbal PIC (Prior Informed consent)[1]. Every informant was informed about the objective of the study and their voluntary participation. The study strictly followed the ethical guidelines for ethnobotanical research and reporting. The data gathered from the informants were then used to collect plants for voucher specimens for preparation of herbarium[18]. At the same time, photo vouchers of the mentioned plant species along with their reproductive parts were also collected during survey. There were certain plants that did not had

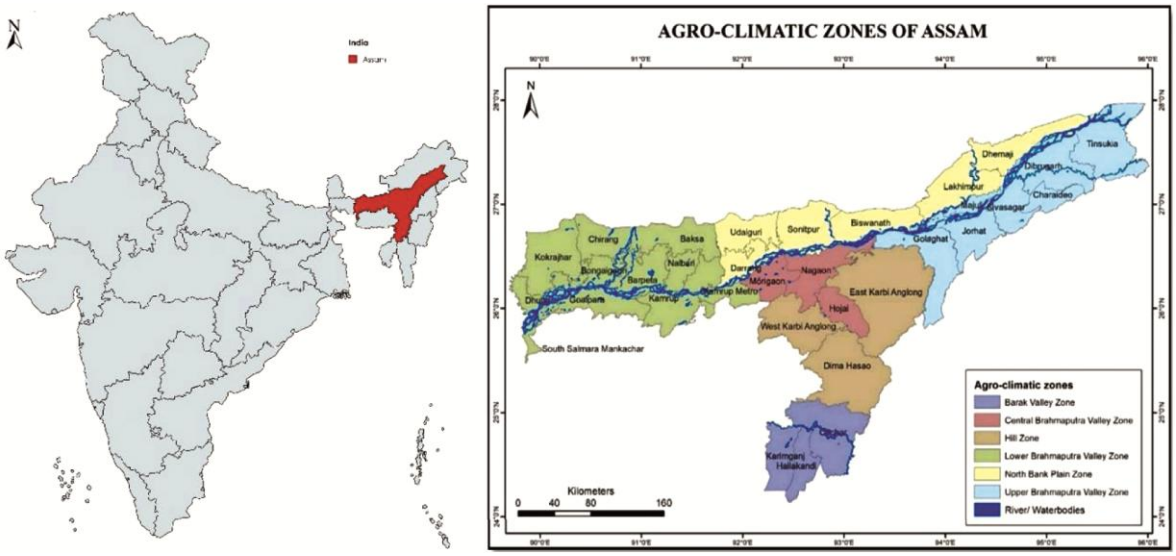

Fig. 1 — Map showing the total districts of LBVZ, Assam, North East India (Source: ARIAS[17])

have any diagnostic characters (flowers/fruits). Hence, a second round of visit to the survey site during the flowering/fruiting season was made to collect photo vouchers of those plant species. The plant species were identified using standard taxonomic literature, particularly the Flora of Assam by Kanjilal *et al*.[19]. The identification was further verified by comparing morphological features with descriptions provided in the literature. The updated scientific names of the plant specimens were authorized and standardised by the online database WFO (https://www.worldfloraonline.org), POWO (https://powo.science.kew.org/) and IPNI (https://www.ipni.org/).

Data analysis

UV (*use value*)

The list of plants was summarised in tabular form and the UV of each plant species was determined[20]. The UV is calculated using the following formula "UV = ∑U/N". Where U is the number of uses mentioned by each informant for a particular species and N is the total number of informants interviewed.

F_{ic} (*informant consensus factor*)

The usage analysis of different taxa against various disease categories was performed using the F_{ic} (Factor of Informant Consensus)[21]. The F_{ic} index helps to determine the homogeneity of the traditional knowledge obtained from the infor mant regarding the use of specific plant species. It was calculated using the formula "$F_{ic} = (N_{ur} - N_t)/(N_{ur} - 1)$". Where N_{ur} is the number of use reports mentioned by the informants, and N_t is the number of taxa used in each disease category.

Results

Demographic characteristics

From the survey of 46 informants were interviewed, whose socio-demographic characteristics are shown in (Table 1).

Taxonomic identification

This investigation has identified 109 species of medicinal plants, covering 97 genera and 53 families. The most prevalent families include Fabaceae, represented by 8 species, followed by Asteraceae with 7 species, and Zingiberaceae and Poaceae, each with 6 species, along with Malvaceae and Lamiaceae, each featuring 5 plant species. The remaining 100 families, along with their respective plant species, UV Index and traditional uses by the Ethnic communities of different regions of LBVZ, Assam is given as Supplementary File (Supplementary Table S1). The photoplates of a few plant species having medicinal properties documented during the survey are given in (Fig. 2).

Use value (UV)

UV reflects the importance of each medicinal plant to the informants without bias. UV will approach 1 if there are many therapeutic use reports for a particular plant species, and near 0 if there are few reports related to its use. In this study, the UV ranges from 0.02-0.13 (Supplementary Table S1). The highest UV has been reported for *Azadirachta indica* and *Zingiber*

Table 1 — Socio-demographic characteristics of the informants in the LBVZ of Assam

Factor	Category	Number of informants	Percentage (%)
Gender	Male	30	65.21
	Female	16	34.78
Age range	30-39	7	15.21
	40-49	14	30.43
	50-59	17	36.95
	60-69	3	6.53
	70 and above	5	10.86
Occupation	Agriculture	13	28.26
	Healers	9	19.56
	Farming	5	10.86
	Daily wage workers/tea pickers	5	10.86
	Small business	5	10.86
	Private sector	4	8.69
	Government sector	3	6.53
	Unemployed/homemaker	2	4.34
Ethnic background	Bodo	18	39.13
	Adivasi (Tea tribes)	11	13.04
	Rabha	6	13.04
	Other caste	6	13.04
	Koch Rajbongshi	5	10.86

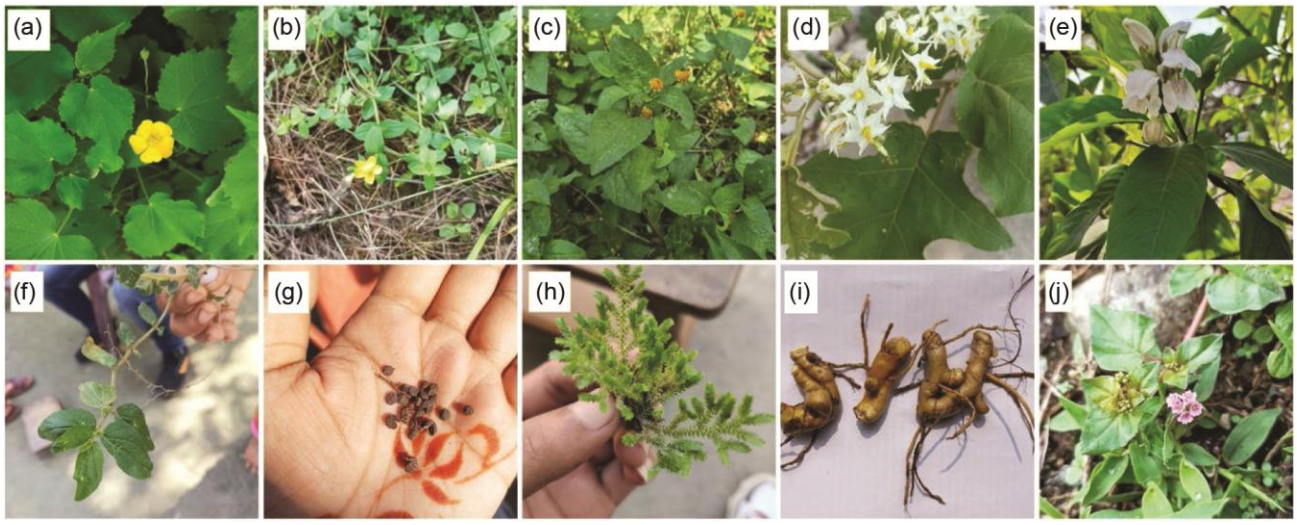

Fig. 2 — *Photoplates of some plants documented during the survey:* (a) *Abutilon indicum,* (b) *Hypericum japonicum,* (c) *Acmella ciliata,* (d) *Solanum torvum,* (e) *Justicia adhatoda,* (f) *Euphorbia hirta,* (g) *Zanthoxylum armatum,* (h) *Selaginella kraussiana,* (i) *Curcuma amada* and (j) *Boerrhavia diffusa*

officinale (0.13 each), followed by *Acmella ciliata*, *Justicia adhatoda*, and *Ocimum tenuiflorium* (0.11 each). The analysis revealed that the phytomedicines exhibited mean UV of 0.0396, with a SE (Standard Error) of ± 0.0027. It is noteworthy as it gives a baseline index of the average importance of a particular species among the traditional practices of the local community.

Plant parts used and mode of preparation and administration of phytomedicines

The leaves constitute 45.73% of the observed usage, with roots accounting for 11.62%. The utilization of other parts is illustrated in (Fig. 3). The primary method of administration involves the oral consumption (73.28%), followed by external application. Approximately 38.80% of herbs are

utilized through juice extraction. The "other" category includes methods such as inhaling the aroma of crushed leaves, consuming the water in which ingredients were soaked, direct chewing, and sleeping on plant leaves, as illustrated in (Fig. 4).

Usage analysis based on the treatment of different diseases

The clinical categorization of viral infections is done on the basis of the organ system affected by the disease. The categories include respiratory (upper respiratory infections), exanthematous, gastrointestinal (gastroenteritis), neurologic (encephalitis, polio and rabies), hepatic (liver infection), cutaneous or mucosal (infections caused by herpes simplex virus and human papillomavirus), haemorrhagic (fevers caused due to infection of blood), multisystem (acute febrile respiratory disease in children), and nonspecific febrile infections[22]. The illnesses that do not fall under any of the above-mentioned categories are recorded as uncategorized as shown in (Table 2 and Fig. 5).

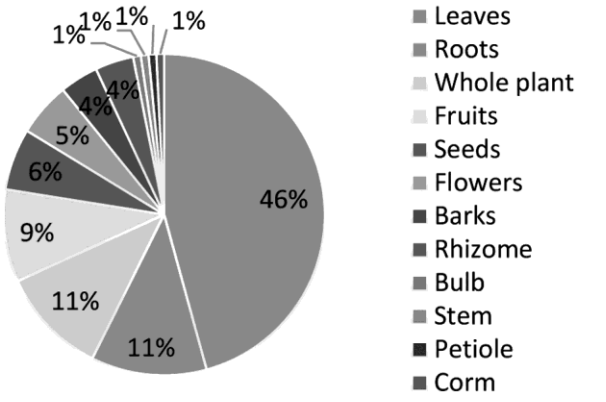

Fig. 3 — Percentage of plant parts used for various ethnomedicinal purposes

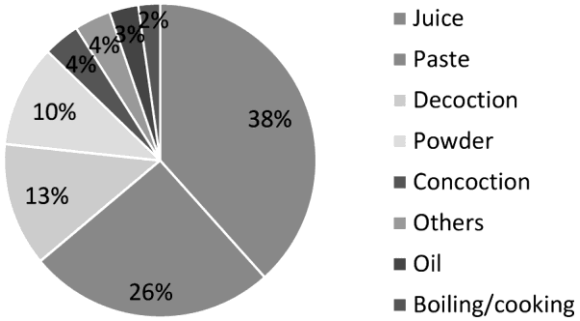

Fig. 4 — Percentage of different mode of preparation of herbal formulations

F_{ic} analysis

The value range of F_{ic} is from 0 to 1, where a value approaching 1 indicates a high degree of consensus among the informants. The value for the hepatic infections is highest having a value of 0.833 followed by respiratory infections as shown in (Fig. 6). These values show the shared and reliable traditional knowledge of the informants and possibly the plant species used are very effective remedies. The remaining disease categories have the least F_{ic} value as shown in (Table 2).

Usage analysis additives

A total of 10 types of substances is used by informants during the preparation of therapeutic formulations. According to the informants, they use additives either as flavouring agents or in some cases to synergize the action of the phytomedicines as shown in (Table 3).

Discussion

The study confirms the hypothesis that the ethnic communities of LBVZ possess diverse traditional knowledge of antiviral medicinal plants, reflecting the critical role of these communities in maintaining and preserving the traditional use of plants and their

Table 2 — Use reports of plants based on different disease category

Disease category	Number of taxa (N_t)	Number of used report (N_{ur})	Percentage of use report (%)	Factor of Informant Consensus (F_{ic})
Respiratory infections	41	65	37.35	0.375
Hepatic infections	34	37	21.26	0.833
Exanthematous infections	20	25	14.36	0.208
Non-specific febrile infections	17	17	9.77	0
Uncategorized	15	17	6.89	0.125
Cutaneous/mucosal infections	7	8	4.59	0.143
Haemorrhagic fevers	4	4	2.29	0
Gastrointestinal infections	4	4	2.29	0
Neurologic infections	2	2	1.14	0
Total uses		174		

interrelationship. This research investigates the traditional use of medicinal plants for treating viral illnesses by Ethnic communities of the LBVZ region of Assam, India. The findings reflect a deep-rooted knowledge system among local communities, where plant-based remedies are routinely used to manage symptoms of viral infections such as fever, cold, cough, flu, and skin eruptions. This underscores their cultural importance in primary healthcare practices. The majority of the informants are members of the Bodo community. Many similar but extensive research have showed their wide understanding of the phytomedicines[9,13]. During the interview, it was observed that only a few were females and most were males, and the majority of them were in their fifties. The young generations are very unfamiliar with the traditional use of plants as they are mainly reliant on the modern synthetic healthcare system. The study by Kumar *et al*.[23] in the Solan district of Himachal Pradesh highlights the gradual loss of traditional knowledge among local communities. One major factor contributing to this loss is modernization and socio-economic changes that has reduced dependence on traditional healing practices, especially among the younger generations. They are becoming more inclined toward modern allopathic medicine, resulting in reduced interest in learning about the plant-based remedies. The migration of individuals towards developed cities, urbanization of rural homes, and changing livelihood patterns have also weakened the conventional pathways through which this historical knowledge was previously passed within families and communities. Similar concerns regarding the traditional knowledge erosion have been documented by Awoke *et al*.[24] in rural communities of Ethiopia. Here, the major threat is increase in agricultural practices, deforestation, changes in lifestyles and modernization of society.

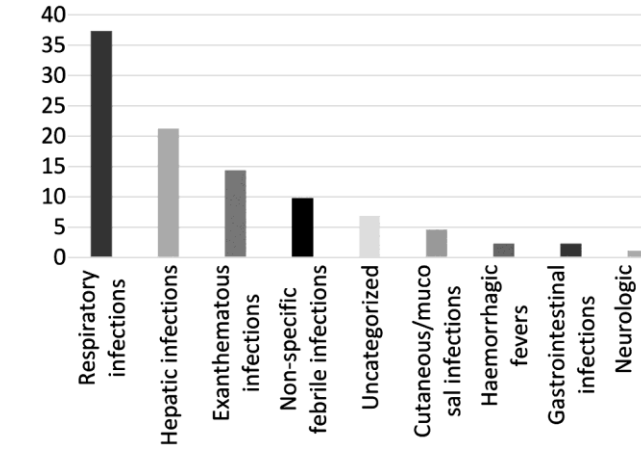

Fig. 5 — Percentage of plant species used against different diseases categories

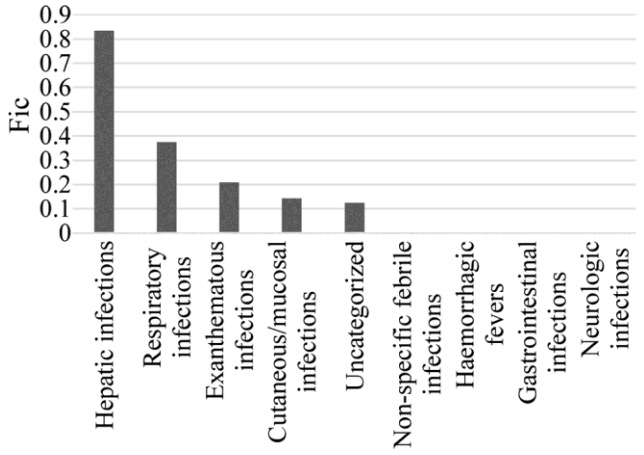

Fig. 6 — Informants' Consensus Factor (Fic) for various disease categories reported by informants

Some informants leveraged their botanical expertise to generate income, particularly given the absence of alternative income source. This also highlights the importance of their knowledge for livelihood generation. In a survey conducted by Chaudhury[25], the trade of wild bioresources has been

Table 3 — Use reports of additives for preparation of formulation

Additives	Type of usage	Number of usages	Percentage (%)
Honey	Flavouring & synergizing	11	10.09
Salt	Flavouring	5	4.58
Goat milk	Synergizing	2	1.83
Sugar	Flavouring	1	0.91
Cow milk	Synergizing	1	0.91
Lime	Synergizing	1	0.91
Curd	Synergizing	1	0.91
Gold (ornament)	Synergizing	1	0.91
Silver (ornament)	Synergizing	1	0.91
Jaggery	Flavouring	1	0.91

shown to contribute between 5% and 75% of total household income, with 158 wild plant species being sold in local markets as food and medicinal herbs. In Northeast India, medicinal plants serve as a significant livelihood asset. The local communities are engaged in the collection, cultivation, and sale of various species through market channels, home gardens, and cottage processing. It helps them to generate a substantial cash income and contribute to healthcare and food security. The dependence on plant resources for treating various illnesses observed in our study is consistent with studies done by Goswami[2] and Mipun *et al*.[26]. They have reported that forest resources and NTFPs (non-timber forest products) play an important role in food security and supplying supplementary income source for the families.

The number of plant species reported depicts the huge floral diversity of Assam. The species like *R. pectinata, M. indica, C. fruticosa, M. cordata, B. nigra, E. tithymaloides, C. fistula, G. glabra, S. alata, C. tamala, C. olitorius, G. oppositifolius, M. acuminata, C. zizanioides, E. indica, T. aestivum, Z. armatum, M. elengi, S. kraussiana, C. frutescens, S. americanum, P. nodiflora, A. subulatum, S. glabra, P. granatum, C. grandis, G. glabra, P. lutea* and *E. cardamomum* have not been reported in previous studies done elsewhere within the district among the LBVZ[8-10,13-16]. The present study provides an introduction of new medicinal plants along with usage information for treating different types of viral diseases. Besides, there are no previous ethnobotanical studies that specifically documented antiviral medicinal plants in LBVZ. Most of the work carried out focuses on general uses like fever, gastrointestinal disorders, skin diseases, respiratory problems, diabetes and other common ailments. Hence, there is a limitation of previous literature with which a direct comparison of antiviral plant diversity can be made. The present study represents a novel attempt to systematically report the use of plants for the treatment of viral diseases in this region by the Ethnic communities.

The bark extract of *A. indica* has been found to possess antiviral activity against HSV Type-1 infection[27]. Kaushik *et al*.[28] showed the effects of *Z. officinale* against the Chikungunya virus *in vitro*. The alkaloids extracted from *J. adhatoda* is a strong inhibitor the major protease of SARS CoV-2[3]. *O. tenuiflorum* is popular among the traditional healers in India and around the world. It is mainly implicated as an immune booster which protects against a wide range of illness in humans[29]. *O. tenuiflorum* has been reported as an expectorant that is a substance that facilitates the removal of phlegm produced in respiratory illnesses[30].

The present study revealed a total of 109 plant species with five species having the highest UV values, highlighting their significance among the informants/healers. However, most of the plant's species are understudied. To mention a few plants seems to be *A. ciliata*, with only a few works revealing its metabolite profile[31-34]. A similar species is *Spilanthes mauritiana* which was proven to have antiviral activity against HSV and Coxsackie virus[35]. A compound known as ferulic acid isolated from *Spilanthes acmella* have a pronounced antiviral effect against HIV-1 virus[36]. The ongoing application of this plant in traditional medicine by various ethnic communities highlights the necessity for further scientific validation and pharmacological investigation.

The plant species, including *A. calamus*, *C. gigantea*, *R. communis*, *C. roseus*, and *Euphorbia spp*. are known to contain bioactive compounds that can be toxic or have irritant properties. Regardless of this, the healers generally rely on controlled doses, specific formulation and careful administration methods. Their knowledge is deeply rooted in the teachings passed down to them from their ancestors and experiences gained from their practices. The toxicological studies by Uebel *et al*.[37] on *A. calamus*, have indicated health risks from high concentrations of the asarone isomers (α-, β-, and γ-asarone). β-asarone poses significant toxicological concern, while α- and γ-asarone require more research to determine their safety profiles. However, the workers have also emphasised the beneficial effects of asarone compounds in experimental studies, including neuroprotective, anti-inflammatory, antimicrobial, and antioxidant properties. Among the various species of *Calotropis*, *C. gigantea* is considered less harmful; however, this plant also contains cardenolide glycosides that can cause severe cardiotoxicity. However, calotropin, a type of cardenolide, has antitumor activity and is known to negatively regulate cancer proliferation in mice and humans[38]. *R. communis* is known to contain a major toxic metabolite known as ricin, which can cause severe illness or death depending on the dose and route of

exposure[39]. The healers generally use the oil obtained from the seed for their practices, and it has been reported that ricin, being a water-soluble substance, is not extracted into the oil. The secondary metabolite of the plants can have therapeutic properties if given at a balanced dose. In the present study, it has been observed that traditional healers generally use *A. calamus* rhizome (powder/juice) in very small quantities and for short durations. Such limited dosing may reduce potential adverse effects while allowing the beneficial properties.

The toxicity of *C. roseus* mainly manifests when ingested at a dose higher than 300 mg. It leads to biochemical and histopathological toxicity in the heart, liver, and kidney. The use of a lower dose is generally recommended for traditional treatment[40]. External application of the flower extract of *C. roseus* by the healers ensures that the patient receives an extremely low dose. Kgosiemang *et al*.[41] reported the skin-irritating properties of different *Euphorbia* spp. due to a bioactive compound known as phorbol in the latex. However, we must also note the metabolites such as flavonoids, phytosterols, anthraquinones, and ellagic acid found in this species. These compounds have very beneficial effects, including antioxidant, antibacterial, anticancer, antiviral, anti-inflammatory, and anti-HIV activities. Nonetheless the presence of toxic compounds necessitates rigorous toxicological validation before their use in the modern medical system.

It appears that different parts of plants hold varying degrees of importance for the informants when preparing herbal medicine. The leaves being most frequently utilized part demonstrate its significance for producing the herbal formulations. This finding indicates that the bioactive compounds are primarily located in the leaves and also agrees with the results of other ethnobotanical studies by Daimari *et al*.[13], Bora *et al*.[15], and Bhattacharjya *et al*.[16]. It has been also noted that the aroma of the crushed leaves is also given to the patients suggesting the role of certain volatile compounds found in the plant parts. The aromatic and volatile organic compounds found in the leaf extract is known to contribute to the therapeutic properties including antimicrobial and protective effects. This is also supported by studies of Ashraf *et al*.[42]. According to York[43], the mode of preparation of formulation and administration of the herbal medicine is very important, as this ensures the release of the active principles to a greater extent compared to other formulations. A specific dosage form will deliver the therapeutic agent at a particular rate. The formulation also determines whether it will have an immediate, sustained, or delayed effect. The various forms of herbal medicines are very important because the medications can only be given in a certain way.

The disease categories analysis demonstrates the informants' proficiency in identifying specific illnesses through symptom assessment. According to the informants, no side effects were reported by the patients but some experienced discomfort while taking the medication orally due to its bitter taste or pungent smell. This primarily urged them to use additives for altering the taste and odour. Although some informants also suggested that the additives function as synergistic agents. They appear to strengthen the efficacy of healing formulation through a certain mechanism which is also supported by Dai *et al*.[44]. In the additive analysis, it has been noted that honey is major additives reported in the study. It has a long history of use as an important ingredient in medicine. The investigation by Dai *et al*.[44] has shown that honey acts as a natural deep eutectic solvent (NADES) due to the presence of glucose, fructose and other bioactive compounds. The use of honey has been shown to enhance the stability, solubility, and bioavailability of active principles in healing formulations made from various plant parts. Komes *et al.*[45] produced goat's milk beverages enriched with medicinal plant extracts. The phytochemical analysis revealed that this beverage had a significantly improved bioactive compound content and profile, which are mainly derived from polyphenolic antioxidants of medicinal plants. The mixture of plant extracts and goat milk also showed enhanced antioxidant capacity comparable to that of green tea, chocolate or coffee. Further investigation could potentially reveal the true mechanism of these substances.

Conclusion

Given the significant impact of the recent SARS-CoV-2 outbreak on India and its implications for pandemic preparedness, there is a pressing need to discover innovative antiviral treatments capable of addressing the virus's mutation rate. Research indicates that the ethnic communities of Assam possess extensive knowledge of the medicinal properties of plants. One of the plant worth noting is *A. ciliata* as it highly common among the local healers and very understudied. As these plants are utilized in their natural state, a comprehensive

analysis is crucial to pinpoint their active components. Combining traditional knowledge with contemporary research could potentially yield safer and more effective antiviral medications while safeguarding this precious cultural legacy.

Supplementary Data

Supplementary data associated with this article is available in the electronic form at https://nopr.niscpr.res.in/jinfo/ijtk/IJTK_25(5)(2026)484-493_SupplData.pdf

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Author Contributions

Conceptualization, data curation, formal analysis, investigation, methodology, and writing the original draft was done by JA. Supervision, validation and review and editing was done by DKB.

Conflict of Interest

The authors declare that they have no competing or conflict of interest.

Ethics Statement

Before conducting the field survey, prior approval was obtained from the informants/healers.

Prior Informed Consent

PIC were obtained from all the informants/healers before the interview.

Data Availability

Data used to support the findings of the study will be made available automatically to public domain after publication.

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