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Green Heritage Of Assam: A Comprehensive Metaanalysis Of Traditional Medicinal Practices

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Abstract

This comprehensive meta-analysis explores the extensive range of traditional medicinal practices in Assam, India. It uncovers the profound ethnobotanical knowledge that is ingrained within the indigenous tribes of Dimasa, Barman, Sonowal, and Bodo. Through a meticulous examination of a dataset comprising 750 entries from 12 tribes and encompassing 354 distinct botanical species, this study sheds light on the diverse and specific plant-based remedies that have been passed down through generations. By utilizing advanced statistical and computational methodologies, such as cluster analysis and Chi-Square tests, our research uncovers significant associations between plant usage and the physiological systems they treat. This underscores the extensive medicinal knowledge held by the Bodo tribe. The results highlight the possibility of combining this conventional knowledge with contemporary medical care, promoting the protection of cultural heritage and biodiversity. This investigation not only adds to the worldwide comprehension of ethnomedicine but also underscores the pressing requirement for recording, sustainable collection methods, and scientific confirmation of traditional treatments. By adopting a comprehensive approach that connects traditional understanding and scientific investigation, this research establishes fresh prospects for medical advancement, sustainability, and the safeguarding of intangible cultural heritage.

Introduction:

The deep interconnectedness between indigenous communities and their natural surroundings in Assam, a state renowned for its abundant biodiversity and cultural legacy in Northeast India, highlights the fundamental nature of traditional medicinal practices. These practices, which are firmly embedded in the indigenous tribes' ethnomedicinal knowledge, such as the Dimasa, Barman, Sonowal, and Bodo - all members of the Kachari clan - exemplify a symbiotic relationship with the region's diverse plant life that has lasted for thousands of years. The dependence on these plants for healthcare is not solely a matter of tradition, but rather a complex interplay of cultural beliefs, ecological comprehension, and practical health applications. This intricate system of knowledge, built upon the therapeutic properties of plants, is an indispensable element of the cultural identity and survival strategies of the tribal communities.

The ethnobotanical knowledge found in Assam signifies a wealth of customary rituals that have been passed down verbally throughout tribal societies across different eras. This serves to underscore the cultural importance of this knowledge, accentuating its contribution to the preservation of biodiversity and the promotion of a harmonious rapport with the natural world (Maass, 1999). The utilization of healing flora, encompassed within these customs, grants us a glimpse into the tribes' profound reverence for and comprehension of their ecological surroundings.

The scientific community at a global level has displayed an ever-growing desire to document and analyze traditional medicinal practices, thus acknowledging their potential in contributing to modern healthcare and the discovery of pharmaceuticals. As stated by (Vontzalidou et al., n.d.), the investigation of ethnobotanical knowledge not only assists in the preservation of cultural heritage, but also in the identification of new pharmacological agents. This convergence of traditional wisdom and scientific research holds the potential for groundbreaking therapeutic solutions, particularly in areas where conventional medicine may have limitations or seeks supplementary treatments.

Despite its significance, the systematic investigation and documentation of the ethnomedicinal practices in Assam continue to lack cohesion and have not been fully explored. There have been limited allencompassing analyses conducted to consolidate this fragmented knowledge into a unified framework that can be utilized for further scientific exploration and conservation endeavors (Buragohain, 2011)(Barbhuiya et al., 2022). The objective of the current study is to bridge this gap by conducting a comprehensive meta-analysis, employing advanced computational tools and statistical methodologies to delineate the ethnomedicinal landscape of Assam's indigenous tribes.

Objectives and Structure of the Study

Our study commences a methodological voyage, commencing with the compilation of ethnobotanical data across a range of tribal communities in Assam. Through meticulous data preprocessing, exploratory analysis, and cluster analysis, our objective is to unveil patterns, similarities, and distinctions in the utilization of medicinal plants. The comparative analysis aims to delve deeper into the specificities of the tribes and establish statistically significant connections that define the practices of traditional medicine in the region. This structured investigation not only advances our comprehension of Assam's ecological legacy but also establishes the framework for integrating traditional medicinal knowledge with contemporary healthcare practices.

By undertaking a mapping exercise of the ethnomedicinal practices of Assam, this research makes a significant contribution to the wider discourse surrounding the conservation of biocultural diversity and the sustainable utilization of medicinal plants. It emphasizes the pressing necessity for the implementation of policies that facilitate the documentation, preservation, and incorporation of traditional knowledge into modern healthcare systems. Furthermore, the discoveries shed light on potential avenues for pharmacological investigation, with particular emphasis on the exploration of rare and underutilized plants that may possess distinctive therapeutic properties.

This establishes the foundation for an in-depth investigation into the customary therapeutic methods in Assam, creating an opportunity for a thorough examination that connects the divide between historical knowledge and contemporary scientific examination. By means of this research, our objective is not solely to safeguard a crucial element of Assam's cultural legacy, but also to delve into its prospective contributions to worldwide well-being and medical practices.

Methodology:

Data Collection and Preprocessing

The investigation initiated with the compilation of ethnobotanical information concentrated on the native communities of Assam, specifically Dimasa, Barman, Sonowal, and Bodo, and many other. This information, meticulously obtained from diverse ethnobotanical assessments and scholarly references, was amalgamated into an all-inclusive data collection, accessible via a designated GitHub repository and an interactive Google Colab notebook.

The first step in preprocessing was to load and clean data using Python's Pandas library. Efforts were made to identify and correct missing values, outliers, and inconsistencies, resulting in a robust dataset for future analysis. Additionally, Numpy was used for numerical data operations, which improved the efficiency of the preprocessing stage.

Exploratory Data Analysis
A thorough exploratory analysis was performed to gain insight into the dataset's underlying structure and characteristics. To gain a preliminary understanding of plant usage patterns, statistical computations were performed with Scipy and Numpy. Matplotlib and Seaborn libraries were used for visual exploration, providing a graphical representation of the data to aid in the identification of trends, patterns, and anomalies.

Cluster Analysis
A cluster analysis was used to investigate the similarities in medicinal plant usage across tribes. The process started with feature selection, which focused on attributes relevant to plant usage patterns. Given the high dimensionality of ethnobotanical data, dimensionality reduction was accomplished using Principal Component Analysis (PCA) with Scikit-learn, which simplified the dataset while retaining essential information.

The clustering algorithms used were K-Means, Hierarchical Clustering, and DBSCAN, all from Scikitlearn. These methods made it easier to group tribes based on similar medicinal plant usage. The Silhouette Score and the Elbow Method were used to assess the clustering's effectiveness and appropriateness, ensuring optimal cluster formation and interpretation.

Comparative Analysis and Statistical Testing
Following cluster analysis, a comparative study was carried out. This phase involved running statistical tests using the Scipy library to compare and contrast plant usage patterns across the identified clusters. The goal was to identify significant differences or similarities in these tribes' medicinal practices, which would contribute to a better understanding of cultural and historical connections.

Reporting and Visualization
The study's findings were presented in detailed reports and advanced visualizations. Matplotlib, Seaborn, and Plotly were used to create informative and engaging graphical representations of the results, which highlighted key aspects of Assam's traditional medicinal practices.

Code Availability and Replicability
In accordance with open science principles, the entire analysis, including data preprocessing, exploratory analysis, cluster formation, and comparative studies, is open to review and replication. The Jupyter Notebook, which is hosted on GitHub and accessible through a Google Colab link, provides a transparent and comprehensive overview of the methodologies and analytical processes used in this study.

Results:

This comprehensive meta-analysis of traditional medicinal practices in Assam includes a dataset of 750 entries from 12 major tribes. The data, compiled from 18 research papers, is organized into columns such as Botanical Name, Family Name, Common Name, Parts Used, Disease, System Used, Method of Use, and Tribe.

Diversity of Medicinal Plants:
A total of 354 distinct botanical species were identified. Houttuynia Cordata was the most quently mentioned species, appearing 12 times, followed by Azadirachta indica, Mimosa Pudica, and Andrographis Paniculata. Fabaceae had the most occurrences among the 91 distinct plant families, followed by Lamiaceae, Asteraceae, and Rutaceae. Figure 1

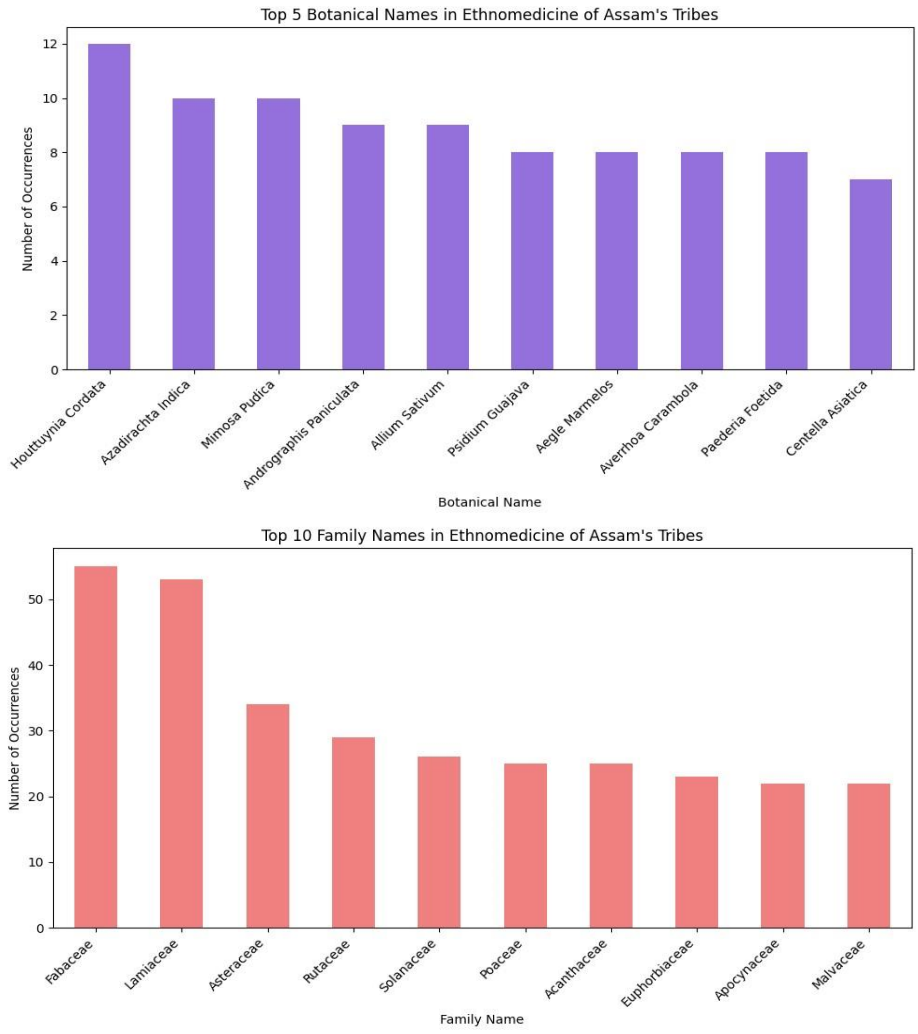

Figure 1: Top 10 Species and Families of plants

Plant Parts Utilized:
Analysis revealed 28 different types of plant parts used, with leaves accounting for nearly half of all cases. Fruits and roots were also widely used. Figure 2

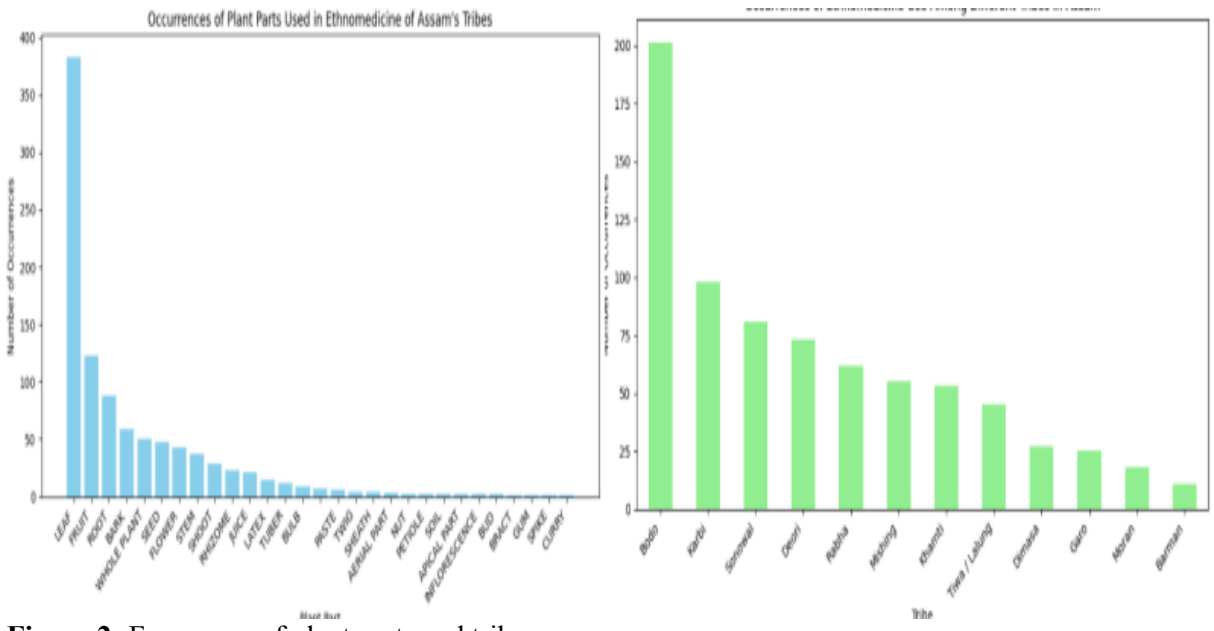

Figure 2: Frequency of plant parts and tribes

Targeted Diseases and Systems:
The dataset covered a wide range of diseases, totaling 430 unique entries. Common ailments included dysentery, jaundice, and diabetes/blood sugar. For standardization, diseases were categorized into 22 unique physiological systems, with the digestive system, circulatory system, and integumentary system being the most frequently addressed.Figure 2 Figure 3

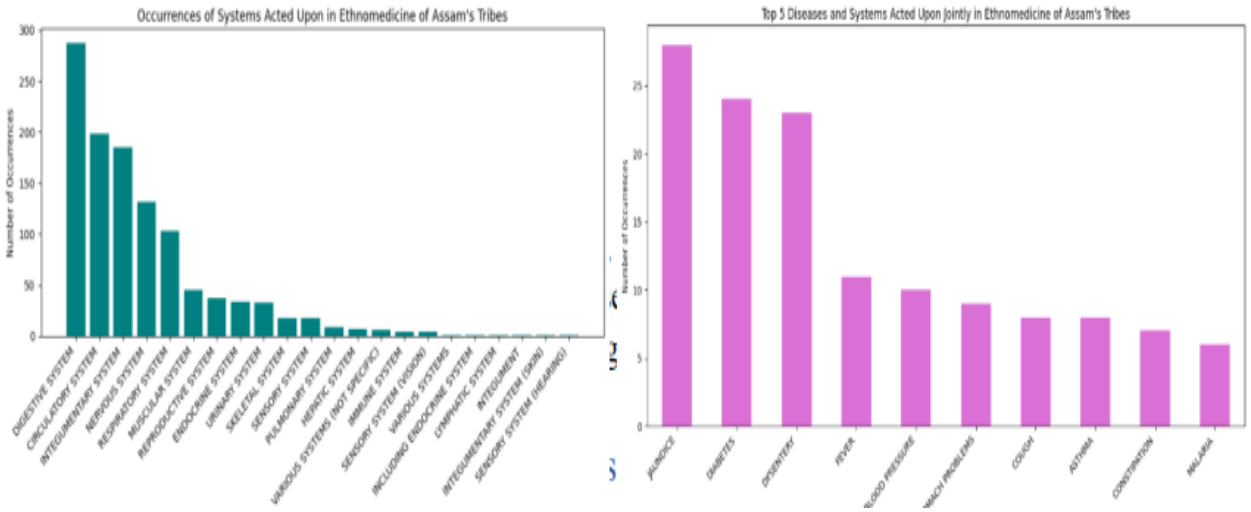

Figure 3: Frequency of disease and Physiological system acted upon

Notable Correlation
A significant connection was discovered between plant families and the physiological systems they influence. For example, Fabaceae and Lamiaceae exerted a wide range of influence across several systems. Fabiaceae and Lamiaceae have specific correlations with the digestive, circulatory, integumentary, and nervous systems.Figure 4

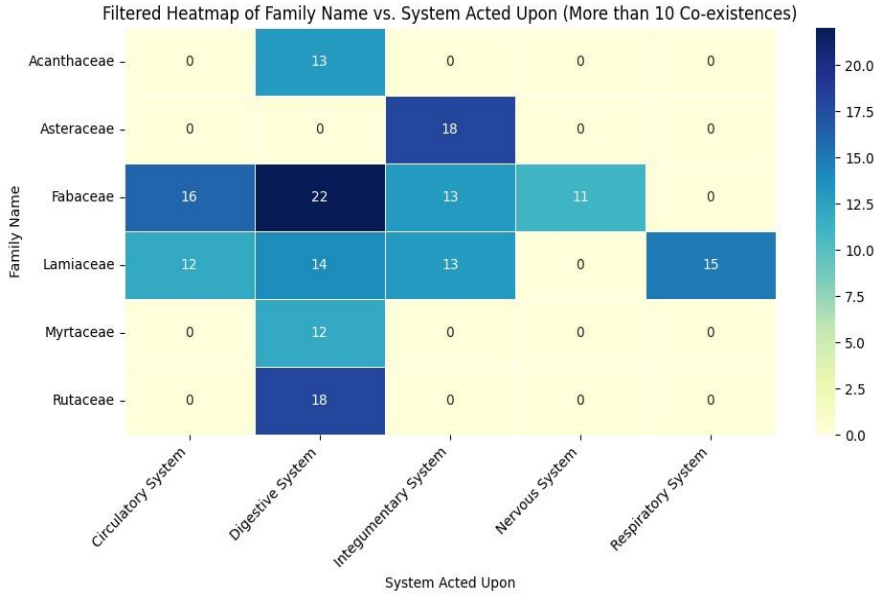

Figure 4: Heat map showing best Correlations between Family and Physiological system acted upon

Statistical Significance of Tribal Associations:
Chi-squared tests revealed a significant relationship between tribes and both the systems affected and the plant parts used. The ChiSquare Statistic for 'Tribe' and 'System Acted Upon' was 606.75 (p-value: 1.59e-35), while for 'Tribe' and 'Parts Used' it was 438.91 (p-value: 1.55e-07). These findings point to specific tribal preferences or tendencies in the use of various plant parts and systems.

Important Plant Usage:
Among Fabiaceae plants species Cajanus Cajan is helpful in Circulatory system, Mimosa Pudica helpful in Digestive system, Cassia Alata helpful in integumentary system, and Mimosa Pudica also helpful in Nervous system. Figure 5

Among Lamiaceae plants species Clerodendrum Galndulosum is helpful in Circulatory system, Mentha arvensis is helpful in Digestive system, Leucas aspera helpful in integumentary system, and Leucas aspera also helpful in Respiratory system.Figure 5

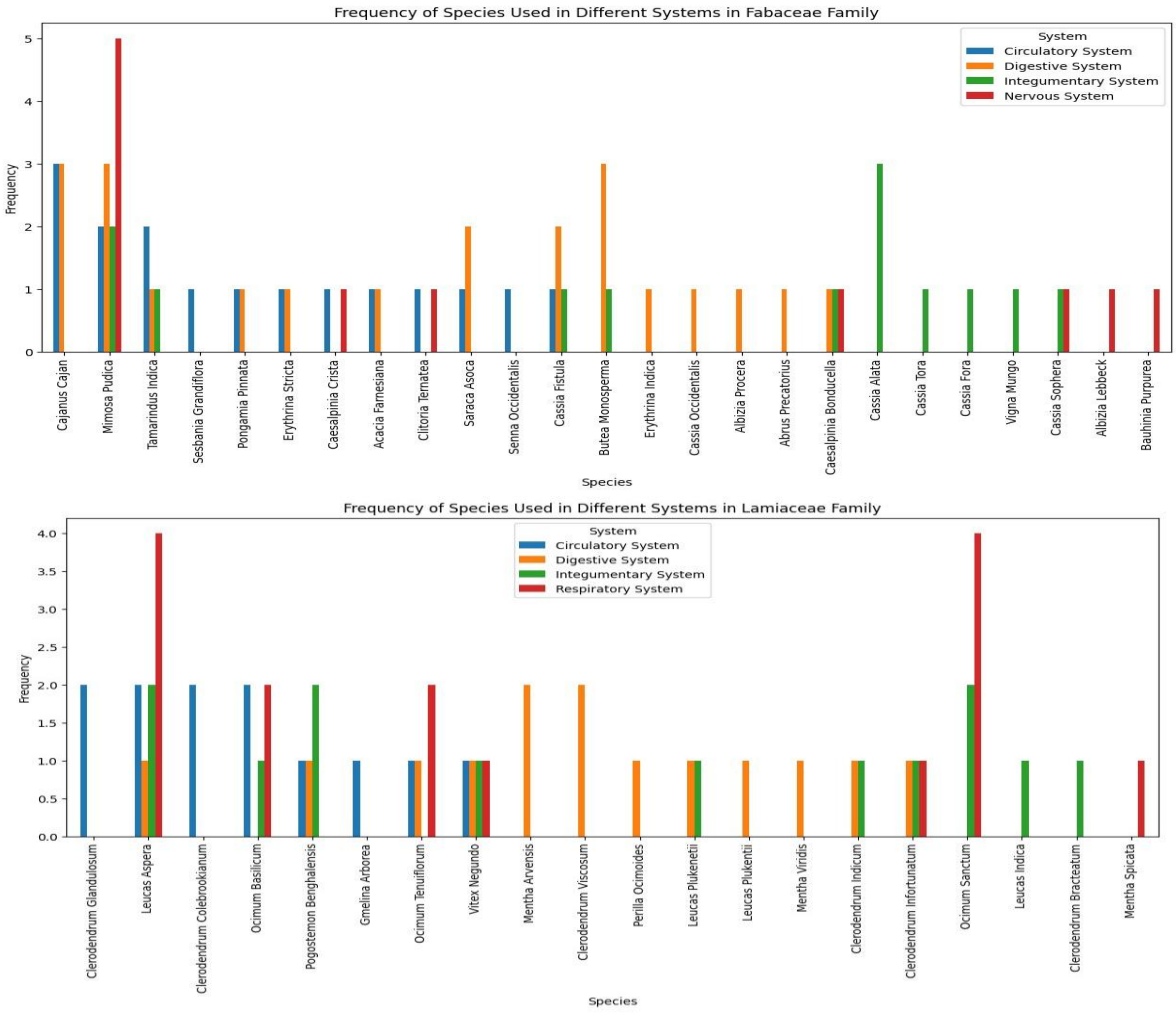

Figure 5: Diving deep into Fabaceae and Lamiaceae Family

Among the rarely used plants, those that treat integumentary and digestive problems were discovered. Plants such as Leucas Plukentii and Polygonum Bracteatum were only mentioned once, indicating that they are not commonly used in traditional medicine.

This analysis focuses on the Assamese tribes' extensive and diverse knowledge of traditional medicinal practices, highlighting the potential for further exploration and integration into modern healthcare.

Discussion:

Our meta-analysis of traditional medicinal practices in Assam sheds light on the region's rich "Green Heritage." Our research has revealed the numerous applications of medicinal plants, emphasizing the intricate knowledge held by various tribes in Assam.

Ethnobotanical Knowledge and Tribal Practices:
The diverse use of plants, particularly in the Bodo tribe, represents a rich repository of ethnomedicinal knowledge. (BORO et al., 2023). This diversity reflects not only Assam's rich biodiversity, but also a deep understanding and cultural integration of these practices among tribes (Doley, 2014). The variation in plant use among tribes, particularly the prevalence of plants from the Fabaceae and Lamiaceae families, highlights the ecological and cultural contexts that shape these practices (Khan et al., 2023).

Importance of Plant Parts and Systems Acted Upon:
The emphasis on specific plant parts, such as leaves and roots, fits into global ethnomedicinal trends, which favor easily accessible and pharmacologically rich plant parts. (Salmerón-Manzano et al., 2020). Traditional remedies' emphasis on the digestive and circulatory systems reflects the prevalence of related ailments and the reliance on natural remedies to manage them. (Ekor, 2014).

The significant correlations revealed by Chi-Square tests between tribes and the systems acted upon (Chi-Square Statistic: 606.75, p-value: 1.59e-35) and between tribes and plant parts used (Chi-Square Statistic: 438.91, p-value: 1.55e-07) suggest a deep-rooted, tribe-specific medicinal knowledge (Rahmatullah et al., 2012). These correlations indicate that medicinal plant use in Assam is not arbitrary but deeply entrenched in tribal traditions and knowledge systems.

Rare Plant Usage and Its Implications:
The identification of rarely used plants, such as Leucas Plukentii and Polygonum Bracteatum, for treating specific ailments points to the existence of specialized knowledge that may be at risk of being lost. These plants could potentially hold untapped pharmacological properties and underscore the urgency of documenting and preserving traditional knowledge (Chouhan & Singh, 2011) (Kalita et al., 2014).

This study not only broadens our understanding of Assam's traditional medicinal practices, but also emphasizes the importance of preserving this intangible cultural heritage. Future research should focus on the pharmacological validation of these practices, which could lead to new therapeutic discoveries. The combination of traditional knowledge and modern healthcare can provide sustainable and culturally appropriate health solutions (Payyappallimana, 2010).

Conclusion:

Our comprehensive meta-analysis of Assam's traditional medicinal practices revealed the profound depth and breadth of ethnomedicinal knowledge held by its indigenous tribes. The study used robust data collection, preprocessing, and analytical methodologies to identify 354 unique botanical species across 750 entries, demonstrating the rich diversity of medicinal plants used by Assam's tribes. Notably, the Bodo tribe has emerged as a significant repository of medicinal knowledge, with distinct plant preferences that highlight the cultural diversity and ecological wisdom of Assam's indigenous populations.
The findings show a strong link between specific plant families and the physiological systems they are used to treat, highlighting indigenous tribes' complex understanding of the natural pharmacopeia at their disposal. The statistical significance of tribal associations with plant parts used and systems applied validates these communities' deep, specialized knowledge of natural remedies. Such insights are invaluable, not only in preserving Assam's cultural heritage, but also in identifying potential pathways for integrating traditional wisdom with modern healthcare systems.

Recommendations

Based on the findings of this study, we make several recommendations to policymakers, healthcare practitioners, and the scientific community:

1. Documentation and Preservation: It is critical to continue documenting the rich ethnomedicinal knowledge of Assam's indigenous tribes. Efforts should be made to preserve this knowledge in digital formats and through community-based initiatives that involve tribal elders and healers, ensuring that it is passed down to future generations.

2. Pharmacological Validation: The scientific community has a significant opportunity to work with tribal healers to validate the therapeutic claims of traditional remedies. Such collaborations can result in the discovery of novel compounds and the development of new drugs, thereby bridging the gap between traditional and modern medicine.
3. Sustainable Harvesting Practices: As people become more interested in traditional remedies, the dangers of overharvesting medicinal plants rise. We recommend implementing sustainable harvesting guidelines, as well as medicinal plant cultivation, to prevent biodiversity loss and ensure the continued availability of these resources.
4. Integration into Healthcare Systems: Policymakers should think about integrating validated traditional remedies into the larger healthcare system. This could include creating integrative medicine programs that provide patients with complementary therapies in addition to conventional treatments.
5. Cultural and Ecological Conservation: Conservation efforts should not only target medicinal plants, but also the cultural practices and ecosystems that sustain them. Protecting Assam's forests and natural habitats is critical for the survival of both biodiversity and traditional knowledge.

Finally, Assam's traditional medicinal practices provide insight into the region's cultural and biological diversity. By embracing and integrating this knowledge, we can not only preserve an invaluable part of Assam's heritage, but also improve global healthcare by providing sustainable, culturally appropriate health solutions. The path forward necessitates a collaborative, multidisciplinary approach that values both indigenous tribes' wisdom and the scientific rigor of modern medicine.

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