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REVIEW ARTICLE

A systematic review of medicinal plants used by indigenous tribal communities of Arunachal Pradesh against diabetes and hypertension

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Abstract

Medicinal plants have been proven crucial for the treatment of several ailments. Despite the advent of modern medicines, majority of the global populations continue to rely on plant-based medicines for addressing primary healthcare needs in the rural localities. The different ethnic tribes of Arunachal Pradesh are reported to be a rich repository of ethnomedicinal knowledge and traditional healthcare practices. The indigenous medicinal knowledge system prevalent among the tribal communities could play a pivotal role in discovery of novel phytotherapeutic compounds effective against diabetes and hypertension. This systematic review aimed at identifying the medicinal plants used by the tribes of Arunachal Pradesh for the treatment of diabetes and hypertension. Present review analysed the data of 17 ethnobotanical papers published on 9 tribes of Arunachal Pradesh and shortlisted medicinal plants used for the treatment of diabetes and hypertension. Analysis revealed 16 medicinal plant species against hypertension and 44 medicinal plant species against diabetes used by the ethnic communities of Arunachal Pradesh. The highest cultural importance index value of 0.75 was recorded for *Clerodendrum colebrookeanum* Walp. which is used by the Adi, Apatani, Galo, Nyishi and Tagin communities. One way analysis of variation revealed significant variation in medicinal plants use with a P-value of 0.02 and F-value of 2.33. Among the 44 medicinal plant species reported against diabetes, the highest cultural importance index value was recorded for *Solanum americanum* Mill. (0.20) used by Adi, Galo, Nyishi and Tagin tribe. The present analysis results suggested for detailed phytochemistry and pharmacological investigation to unveil the therapeutic potential of the selected medicinal plants reported to be traditionally used against diabetes and hypertension.

Keywords: Medicinal Plants; Ethnic Communities; Hypertension; Diabetes; Systematic Review; Arunachal Pradesh

1. Introduction

Development of modern medicines have significantly contributed towards effective treatment and management of several human ailments. Pharmacological advancements in 21st century have led to the discovery of novel and affordable drugs for the treatment of diseases that inflict global population, however, majority of the global population in developing countries still prefer plant based traditional herbal medicines for their primary healthcare needs (WHO, 2023). These medicinal plants are generally prescribed to the patients by elderly trained healers of the various tribal communities. The knowledge of these indigenous medicinal practices is well-kept secret in various communities and which is orally transferred to the next generation. Diabetes and hypertension exhibit an overlapping trend which affects the lives of millions of populations across the world (Tsimihodimos, 2018). Diabetes damages the thin blood vessels causing its wall to stiffen and this results in increase of blood pressure leading to hypertension (Smulyan et al., 2016). Diabetes coupled with hypertension elevates the risk of heart diseases and stoke (Kozakova and Palombo, 2016). Approximately, 422 million individuals have been diagnosed with diabetes which is expected to cause mortality of 1.5 million people each year (WHO, 2019). In the past few decades, several antidiabetic drugs have been discovered for treatment of diabetes and hypertension. However, the results and efficacy of these drugs are reported to be inadequate and shows considerable side effects. In addition, the high-cost involvement in diabetes and hypertension treatment exerts substantial economic and clinical burdens on the patients (Vincent et al., 2018). Thus, increase side effect and cost escalation of blockbuster anti-diabetic drugs in the market have forced the patients to shift towards traditional and alternative form of medicines which are mainly based on medicinal plants.

The state of Arunachal Pradesh in North East India is inhabited by 28 tribes with rich ethnomedicinal heritages (Tag et al., 2008; Jambey et al., 2017). These tribes are dispersed over different geographical locations and exhibit unique lifestyles, dialects and cultural practices which differ from one another. The indigenous tribes of the state are deeply connected to the forest bioresources and shows extraordinary knowledge of the plant resources and primarily rely on medicinal plants for treatment of commonly known ailments prevalent in their traditional biocultural landscape (Rinyo et al., 2021). Each tribe has their own way of addressing the cause and effect of the ailments or diseases which includes the preference of the medicinal plant, and development of unique methods of herbal formulation for treatment of diabetes and hypertension (Bipul et al., 2017). Perusal of literatures have revealed numerous ethnomedicinal study reports on medicinal plants used by the tribal communities of Arunachal Pradesh. However, majority of the study reports available to date are tribe specific which is related to a particular geographical location. Thus, this systematic review is undertaken with the aim to generate quantitative information regarding the medicinal plants used for the treatment of diabetes and hypertension by different tribes of Arunachal Pradesh, India.

2. Methods of data collection and analysis

Data were pooled from published articles using Google scholar, Scopus and PubMed database. The pooled data which did not provide standard ethnobotanical methods, scientific plant names, mode of preparation, informant detail, geographical area and the tribes were excluded from the present analysis (Figure 1). Scientific names of all the medicinal plants obtained were updated following World Flora Online (http://www.worldfloraonline.org/) and included in this study. Cultural Importance Index (CI) was calculated to rank the importance of medicinal plants (Tardío and Pardo-de-Santayana, 2008)

$$CI = \frac{UR}{N}$$

Where UR = total number of use reports for a species.
N = total number of pseudo-informants.

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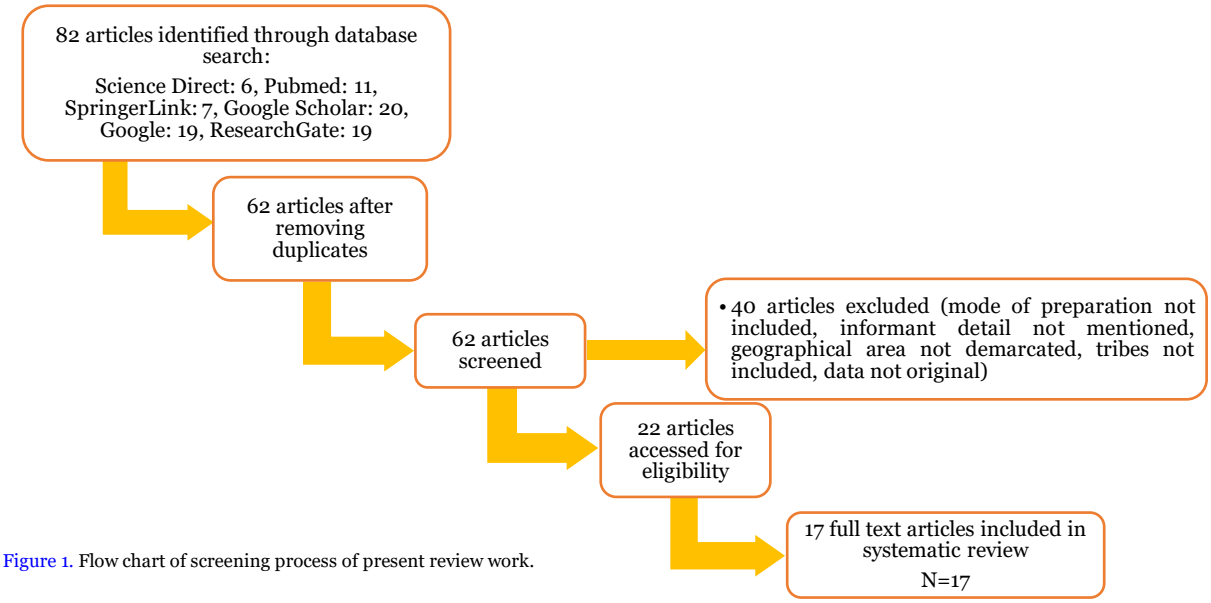

Figure 1. Flow chart of screening process of present review work.

Table 1. Cultural importance index (CI) of medicinal plants used for the treatment of Hypertension.

Medicinal Plants	Family	Adi	Apatani	Galo	Nyishi	Tagin	Tai Khamti	Total CI
Bidens pilosa L.	Asteraceae	0.05	-	-	-	-	-	0.05
Carica papaya L.	Caricaceae	-	-	-	-	-	-	0.05
Centella asiatica (L.) Urb.	Apiaceae	0.05	-	-	-	-	0.05	0.10
Clerodendrum colebrookeanum Walp.	Lamiaceae	0.23	0.23	0.11	0.11	0.05	-	0.75
Clerodendrum infortunatum L.	Lamiaceae	-	-	-	0.05	-	-	0.10
Litsea cubeba Pers.	Lauraceae	-	-	0.05	0.05	0.05	-	0.15
Lycianthes glandulosa (Ruiz & Pav.) Bitter	Solanaceae	0.05	-	0.05	0.05	0.11	-	0.26
Paederia foetida L.	Rubiaceae	0.05	-	-	-	-	-	0.05
Phoebe bootanica (Meisn.) M. Gangop	Lauraceae	0.05	0.05	0.05	0.05	0.05	-	0.25
Piper pedicellatum C.DC.	Piperaceae	0.05	-	0.05	0.05	0.05	-	0.20
Rauvolfia serpentina Benth. ex Kurz	Apocynaceae	-	-	-	0.05	-	-	0.05
Senna tora (L.) Roxb.	Fabaceae	-	0.05	-	-	-	-	0.05
Solanum spirale Roxb.	Solanaceae	-	-	-	-	0.05	-	0.05
Solanum torvum Sw.	Solanaceae	-	-	0.05	-	-	-	0.05
Syzygium cumini (L.) Skeels	Myrtaceae	-	-	0.05	-	-	-	0.05
Zingiber zerumbet (L.) Sm.	Zingiberaceae	-	-	0.05	-	-	-	0.05

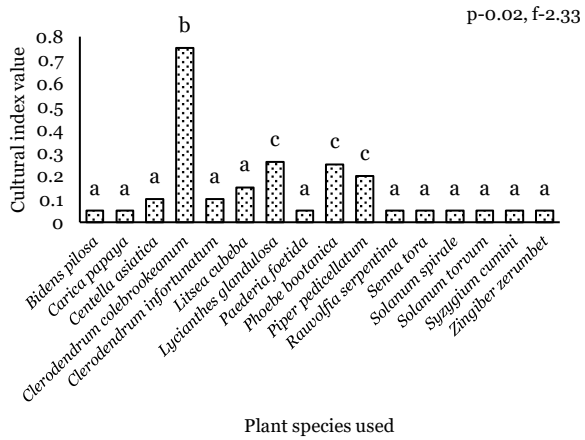

Figure 2. Cultural importance index of medicinal plants used for the treatment of hypertension. Same letter on top does not differ significantly according to one way analysis of variation at P≤0.05.

For this systematic analysis, pseudo-informants refer to a data source rather than an individual. A higher value of CI closer to one would indicate the same use for a particular disease among the tribes and values near to zero indicates different tribes who use the plant for different purposes.

3. Result

From the 17 ethnobotanical reports screened, 9 tribes namely, Adi, Apatani, Galo, Tai Khamti, Monpa, Nocte, Nyishi, Singpho and Tagin were using medicinal plants for treatment of diabetes and hypertension. The medicinal plant usage was reported from 40 villages within 9 districts *i.e.*, East Siang, Lohit, Lower Subansiri, Papum Pare, Tirap, Upper Siang, West Siang and Ziro. The published data were gathered by the investigators from local informants using semi structured questionnaires and informal interview and followed by focused group discussion methods. Most of the informants were reported to be the traditional healers (4 studies) and the rest were either local villagers, village Chiefs or elders having indigenous utilization knowledge of the medicinal plants. The informants were found to be in the age group between 30-70 years which comprises of 234 male and 153 female informants.

From the 17 published literatures, 16 medicinal plant species have been identified to be distributed across 14 genera and 11 families which were used for hypertension. The highest Cultural Importance Index value of 0.75 was recorded for *Clerodendrum colebrookeanum* Walp. which was used by the Adi, Apatani, Galo, Nyishi and Tagin tribes of Arunachal Pradesh (Table 1). One way Analysis of Variation revealed significant variation in medicinal plants use with a P-value of 0.02 and F-value of 2.33 (Figure 2). The highest number of plant species for curing hypertension was recorded from the Galo tribe (8) followed by Adi and Nyishi (7) and only single species was used by Singpho (*Clerodendrum infortunatum* L.), Tai Khamti (*Centella asiatica* (L.) Urb. and Nocte (*Carica papaya* L.) tribe (Figure 4). Furthermore, a total of 44 medicinal plant species distributed within 40 genera and 29

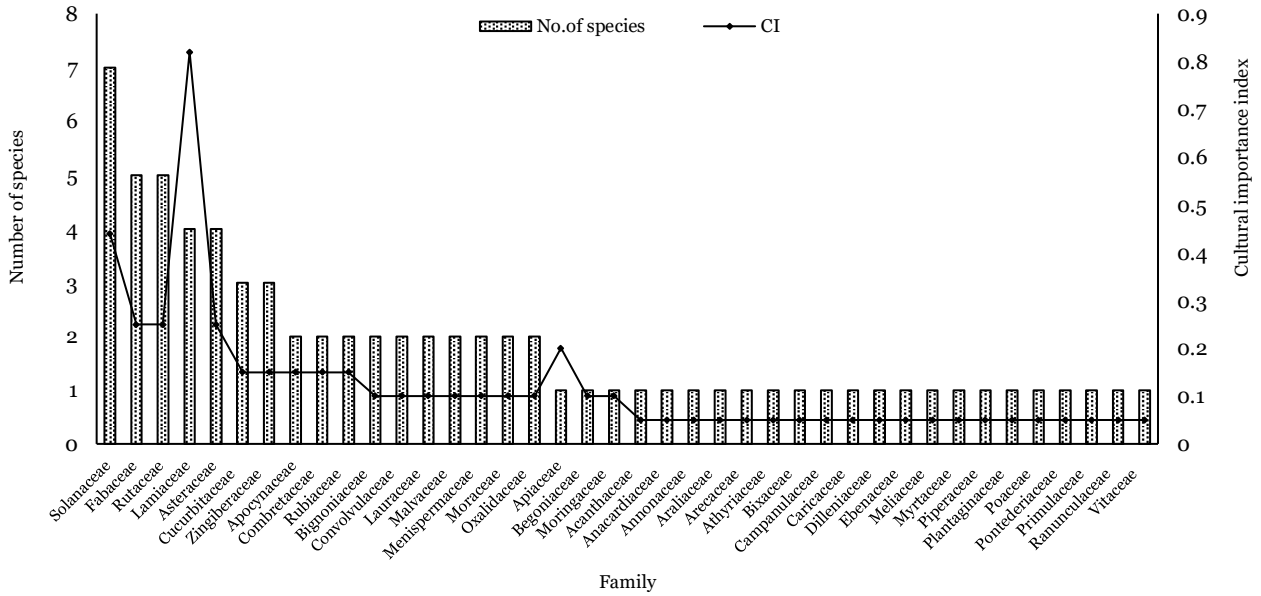

Figure 3. Number of plant families used and its cultural importance index against hypertension and diabetes.

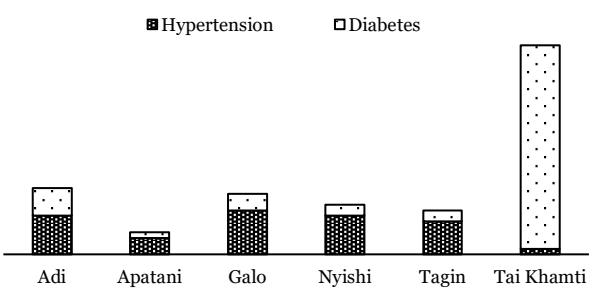

Figure 4. Medicinal plants used by different tribes against hypertension and diabetes.

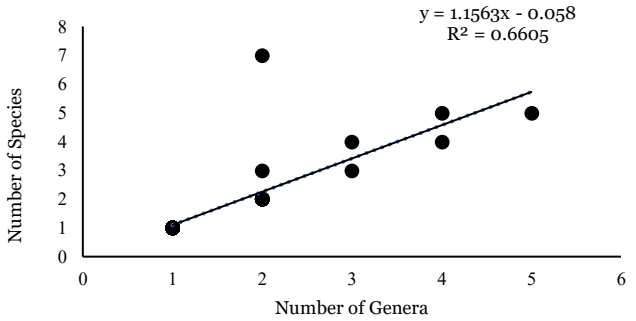

Figure 5. Correlation coefficient of number of genera and species of medicinal plants used by different tribes.

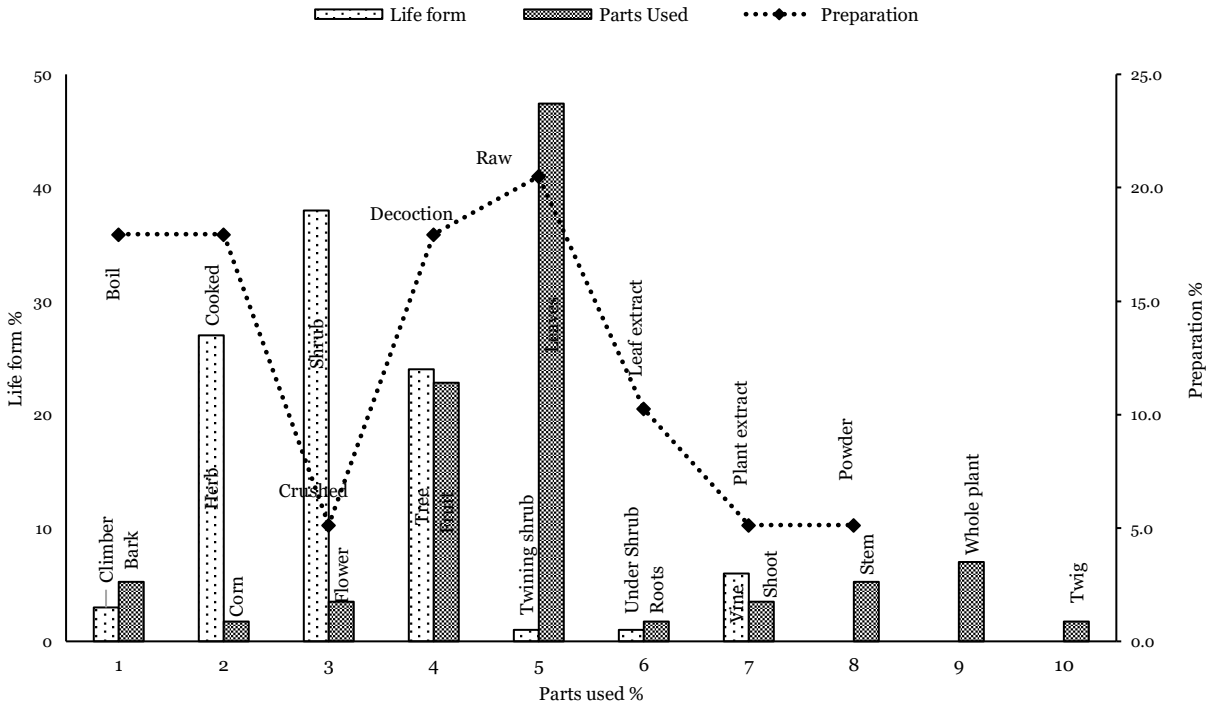

Figure 6. Life form, parts used and mode of preparation of medicinal plants.

families have been reported for the treatment of Diabetes. The

Table 2. Cultural importance index (CI) of medicinal plants used for the treatment of Diabetes.

Medicinal plants	Family	Adi	Apatani	Galo	Nyishi	Tagin	Tai Khamti	Total CI
Abelmoschus esculentus Moench	Malvaceae	-	-	-	-	-	0.05	0.05
Andrographis paniculata (Burm.f.) Wall.	Acanthaceae	-	-	-	0.05	-	-	0.05
Annona squamosa L	Annonaceae	-	-	-	-	-	0.05	0.05
Ardisia pedunculosa Wall.	Primulaceae	-	-	-	-	-	0.05	0.05
Averrhoa carambola L.	Oxalidaceae	-	-	-	-	-	0.05	0.05
Azadirachta indica A.Juss.	Meliaceae	-	-	-	-	-	0.05	0.05
Bauhinia purpurea L.	Fabaceae	-	-	-	-	-	0.05	0.05
Begonia roxburghii (Miq.) A.DC.	Begoniaceae	0.05	-	-	-	-	0.05	0.10
Bergera koenigii L.	Rutaceae	-	-	-	-	-	0.05	0.05
Bidens pilosa L.	Asteraceae	-	-	-	-	-	0.05	0.05
Bixa orellana L.	Bixaceae	0.05	-	-	-	-	-	0.05
Calamus tenuis Roxb.	Arecaceae	-	-	-	-	-	0.05	0.05
Callicarpa arborea Roxb.	Lamiaceae	-	-	-	-	-	0.05	0.05
Catharanthus roseus (L.) G.Don	Apocynaceae	-	-	0.05	-	-	0.05	0.10
Citrus aurantiifolia (Christm) Swingle	Rutaceae	-	-	-	-	-	0.05	0.05
Clerodendrum colebrookaenum Walp.	Lamiaceae	-	-	-	-	-	0.05	0.05
Clerodendrum infortunatum L.	Lamiaceae	-	-	-	-	-	0.05	0.05
Coccinia grandis (L.) Voigt	Cucurbitaceae	-	0.05	-	-	-	-	0.05
Coptis teeta Wall.	Ranunculaceae	-	-	-	-	-	0.05	0.05
Curcuma caesia Roxb.	Zingiberaceae	-	-	-	-	-	0.05	0.05
Cuscuta reflexa Roxb.	Convolvulaceae	-	-	-	-	-	0.05	0.05
Dillenia indica L.	Dilleniaceae	-	-	-	-	-	0.05	0.05
Diplazium esculentum (Retz.) Sw.	Athyriaceae	-	-	-	-	-	0.05	0.05
Ficus hispida L.f.	Moraceae	-	-	-	-	-	0.05	0.05
Hedyotis scandens Roxb.	Rubiaceae	-	-	-	-	-	0.05	0.05
Ipomoea aquatica Forssk.	Convolvulaceae	-	-	-	-	-	0.05	0.05
Ixeridium gracile (DC.) Pak & Kawano	Asteraceae	-	-	-	-	-	0.05	0.05
Lobelia chinensis Lour.	Campanulaceae	-	-	-	-	-	0.05	0.05
Maclura cochinchinensis (Lour.) Corner	Moraceae	-	-	-	-	-	0.05	0.05
Millingtonia hortensis L.f.	Bignoniaceae	-	-	-	-	-	0.05	0.05
Momordica dioica Roxb. ex Willd.	Cucurbitaceae	-	-	-	-	-	0.05	0.05
Moringa oleifera Lam.	Moringaceae	-	-	-	-	-	0.05	0.05
Oroxylum indicum (L.) Benth. ex Kurz	Bignoniaceae	-	-	-	-	-	-	0.05
Oxalis griffithii Edgew. & Hook.f.	Oxalidaceae	-	-	-	-	-	0.05	0.05
Paederia foetida L.	Rubiaceae	-	-	-	-	-	0.05	0.05
Panax pseudoginseng Wall.	Araliaceae	-	-	-	-	-	0.05	0.05
Pongamia pinnata (L.) Pierre	Fabaceae	-	-	-	-	-	0.05	0.05
Pontederia vaginalis Burm.f.	Pontederiaceae	-	-	-	-	-	0.05	0.05
Saccharum spontaneum L.	Poaceae	-	-	-	-	-	0.05	0.05
Scoparia dulcis L.	Plantaginaceae	-	-	-	-	-	0.05	0.05
Solanum americanum Mill.	Solanaceae	0.05	-	0.05	0.05	0.05	-	0.20
Solanum anguivi Lam.	Solanaceae	0.05	-	0.05	-	0.05	-	0.15
Solanum viarum Dunal	Solanaceae	-	-	-	-	-	0.05	0.05
Solanum violaceum Blume	Solanaceae	0.05	-	-	-	-	-	0.05

highest Cultural Importance Index value was recorded for *Solanum americanum* Mill. (0.20) used by Adi, Galo, Nyishi and Tagin tribes which is followed by *Solanum anguivi* Lam. (0.15) used by Adi, Galo and Tagin (Table 2). No significant variation in Cultural Importance Index was observed which is evident from One Way Analysis of Variance ($P \leq 0.05$). Among all the tribes, the Tai Khamti of Namsai and Lohit district used the highest number of medicinal plants (37) and only one plant species was reported to be used by Monpa tribe (*Oroxylum indicum* (L.) Benth. ex Kurz) for the treatment of diabetes (Figure 4).

The highest number of plant species were used for the treatment of diabetes and hypertension belonging to the family Solanaceae (7 species). This is followed by Fabaceae and Rutaceae (5 species each). Out of the total 40 families reported, Lamiaceae (Figure 3) has been reported with highest total Cultural Importance Index value of 0.82 which is followed by Solanaceae (0.44), Fabaceae, Rutaceae, and Asteraceae (0.25) and the rest of the plant families were reported with total CI value less than 0.2 (Figure 5). A significant positive correlation ($r^2 = 0.66$, $p > 0.05$) between the number of genera and species were found to be used as medicine by the different tribes of Arunachal Pradesh (Figure 5).

Different life forms of medicinal plant species were reported to be used by the indigenous tribes for the treatment of hypertension and diabetes. Shrubs constituted 38% of the total life form used which is followed by herbs (27%), trees (24%), vine (3.5%), climber (3%), shrub (1%) and undershrub (1%). Leaves were the most preferred plant part harvested which accounts for 47.4% of the total parts harvested and used by the traditional healers which is followed by fruits (22.8%). In contrast, corm, toots and twigs were reported to be the least plant part used (1.8%). Most of the medicinal plant and their parts are consumed in raw form by the tribes of Arunachal Pradesh, which accounts for 20.5%. This is followed by boiling, cooking and decoction (17.9%). The crushed, extract and powder (5.1%) (Figure 6) were found to be the least preferred mode of crude drug preparation.

4. Discussion

The data generated from the current analysis represents the largest dataset for the treatment of diabetes and hypertension by the tribes of Arunachal Pradesh. A total of 16 medicinal plant species belonging to 11 families, and 44 medicinal plant species belonging to 29 plant families have been identified which were reported to be used by the herbal healers for the treatment of diabetes and hypertension respectively. While comparing their cultural importance value (CI) index, *Clerodendrum colebrookeanum* was the most commonly used plant species for the treatment of hypertension among the six tribes of Arunachal Pradesh. According to Kalita et al (2013) *Clerodendrum colebrookeanum* is one of the most preferred medicinal plants among the different tribes of North-Eastern India for the treatment of various ailments and particularly reported to be effective against hypertension. Namsa et al (2011) and Tangjang et al (2011) recorded Fidelity level of 100% and Wangpan et al (2019) recorded 96% for *C. colebrookeanum* for treating hypertension among the Monpa, Nocte, Nyishi, Tagin, Galo and Adi tribes of Arunachal Pradesh. The ability to cure hypertension using *C. colebrookeanum* may be attributed to the presence of acteoside, martinoside, and osmanthuside β6 (Lokesh and Amitsankar, 2012).

Present review and analysis revealed valuable information on the prevalence of hypertension in Arunachal Pradesh. The use of plant-based medicine for the treatment of hypertension was recorded highest among the Galo followed by Adi and Nyshi tribe which indicating that the greater majority of the people from these tribes suffer from hypertension and prefer medicinal plants for treatment in rural localities. The use of *C. colebrookeanum* for treating hypertension is also reported from tribal communities living in different part of India. Harsha et al (2002) reported the use of *C. colebrookeanum* by the Kunabi tribe of Karnataka. The use of the same plant for the treatment of a particular ailment by different tribes indicating their pharmacological and therapeutic potential.

The study also revealed multicurative properties of *C. colebrookeanum* since it has also been reported to be used for the treatment of other disorders like stomach disorder, and headache among the Monpa community and liver pain, viral fever among the Adi community of Arunachal Pradesh (Tag et al., 2008; Jambey et al., 2017).

About 300 million people are suffering from diabetes globally and it has been further estimated that 57 million people will be affected in India by the year 2025 (Perme et al., 2022). Diabetes is a common metabolic disorder which affects major vital systems of the body (Umamageswari, 2017). Present finding revealed *Solanum americanum* Mill. as the potential species with highest cultural importance index suggesting its preference for treatment of diabetes. The *S. americanum* has been reported to be used by Adi, Galo, Nyishi and Tagin tribes (Tag et al., 2008; Wangpan et al., 2019; Rinyo et al., 2021). Literature survey further revealed that *S. americanum* is used by majority of tribes for treating different disorders. According to Poongothai et al (2010) and Umamageswari et al (2017), the aqueous extract of *S. americanum* is used as analgesic, antispasmodic, anti-inflammatory and vasodilator. Similar finding of ethnomedicinal uses of *S. americanum* have been reported from other tribes of India for treatment of diabetes (Singh et al., 2014). While investigating type 2 diabetes among the Cakchiquels in Guatemala, Cruz and Andrade-Cetto (2015) reported UV of 0.69 and DCI (Disease Consensus Index) of 0.65 for *S. americanum*. Poongothai et al (2010) further reported the ability of *S. americanum* to repair and enhance pancreas beta cells and insulin secretion in the cell membrane. The secretion of insulin is reported to be due to the presence of saponins in the aqueous extract (Aali et al., 2010). Further, Meonah et al (2012) observed that extract of *S. americanum* contains alkaloids, phenolics and flavonoid contents and concluded that the presence of these bioactive phyrocompounds in the extract of leaf and fruits might be responsible for hypoglycaemic activity and regeneration of islets of Langerhans (Umamageswari et al., 2017).

Solanaceae has been reported to be an important angiosperm plant family comprising of many important species of food and medicinal potential (Ghatak et al., 2017; Chowanski et al., 2016). The family comprises of more than 3000 species and 100 genera with considerable economic importance and are widely used as a source of food and medicinal agents (Shah et al., 2013; Chowanski et al., 2016). The presence of bioactive compounds such as antimicrobial, alkaloids, steroids, simple phenols, etc (Ghatak et al., 2017) makes the Solanaceae family medicinally important. The higher use of species belonging to Solanaceae may be due to easy availability, as the plants from this family are known to have wide distribution in different agroclimatic region (Rinyo et al., 2021). Among the different plant families recorded, Lamiaceae exhibited highest Cultural index due to its rich secondary metabolite contents which exhibits broad spectrum of biological activities. The use of Lamiaceae members as medicinal agents by the tribes of Arunachal Pradesh have been reported to be mainly based on the inherited skills or due to acquired and exchanged traditional knowledge. Medicinal plant species harvested among the tribes were found to be consumed in raw form by the local people as they believe that the plant tend to lose their medicinal potential after excessive heating and cooking. Leaves and shrubs were reported to be commonly harvested plant part and lifeform used because harvesting the leaves does not kill the plant thus allowing it to be regenerated which could be harvested again while preference of shrub is due to its easy harvest and availability in their biocultural landscape.

6. Conclusion

The state of Arunachal Pradesh is blessed with rich biodiversity and traditional ethnomedicinal knowledge associated with treatment of diabetes and hypertension used by the 28 tribes in their native biocultural landscape. From the present analysis of important ethnomedicinal literatures, it is confirmed that *Clerodendrum colebrookeanum* Walp and *Solanum americanum* Mill. are the most preferred plant species among the tribes of Arunachal Pradesh for the treatment of hypertension and diabetes respectively. However, it is also evident from the literatures that documentation of ethnomedicobotanical knowledge of all the major tribes of Arunachal Pradesh is currently lacking which need further field investigations to unveil the hidden secrets of the rural folk healing system. Majority of the present secondary data were found to be obtained from traditional healers which were gathered by investigators by using structured, semi-structures questionnaire format and focused group discussions. Thus, focused endeavour should be made for the validation of the ethnobotanical claims of on some of these important medicinal plants with high CI index by isolating the bioactive phytocompounds effective against diabetes and hypertension.

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Author contributions

The author has solely contributed to the conception, design, manuscript preparation and correction.

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