



RESEARCH COMMUNICATION

# Traditional remedies for diabetes used by the Ao (Naga) tribe in Mokokchung district, Nagaland, India

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## Abstract

Diabetes, a metabolic disorder, poses a significant global health challenge and is recognized as a major non-communicable disease. This widespread issue not only impacts the well-being of individuals but also poses economic burdens, particularly on developing nations. Consequently, there is a pressing need for appropriate solutions and effective medicines, making it a focal point of research globally. Despite remarkable progress in modern allopathic medicine, there exists no definitive cure for diabetes within this system. Additionally, allopathic drugs, while beneficial, often come with severe side effects that can lead to various physiological disorders. In the light of these challenges, ethnobotanical exploration emerges as a viable alternative, providing an avenue to identify potential folk medicines for treating metabolic disorders.

The current study aimed to investigate the diversity of medicinal plants traditionally used by the Ao (Naga) tribe in Mokokchung for diabetes treatment and to document these folk remedies. Mokokchung district, Nagaland, is home to the Ao (Naga) tribe, a community reliant on ethnomedicinal herbs for their daily needs and healthcare. The study, conducted between September 2021 and March 2022, involved structured interviews with traditional healers to collect information on their use of medicinal plants in managing various ailments. The study findings underscored the richness of medicinal plants and folk formulations employed in diabetes treatment within the Mokokchung district of Nagaland. A total of 32 medicinal plant species from 26 families were documented. Despite the advancements in modern medicine, traditional ethnomedicinal practices are gradually losing favor, particularly among younger generations, leading to the erosion of this invaluable knowledge. Hence, there is an urgent need for further scientific investigation to validate the claims and efficacy of folk medicines used for diabetes treatment. In this background, there is a critical requirement for inventory, documentation and scientific validation of these practices and folk medicines. Immediate attention to these efforts is crucial to preserve this invaluable knowledge and facilitate its integration with modern medical practices, ensuring the preservation and effective utilization of this traditional wisdom.

## Keywords

Traditional treatment; Ethnomedicine; Diabetes; Mokokchung; Ao (Naga) tribe

## Introduction

In the present century, diabetes has emerged as predominant metabolic disease among humans. The numbers of diabetic cases are increasing rapidly due to unhealthy lifestyle(1). According to the World Health Organization (WHO) in 2019, diabetes was responsible for 1.5 million deaths worldwide, with 48% of those deaths occur before 70 years of age. Diabetes is a global public health crisis that impacts the health and economies of all nations, with developing countries being particularly affected (1, 2). Currently, people generally rely on the allopathic system of medicine and modern treatments to overcome diabetes. However, a permanent solution to this problem is still lacking. Therefore, it is crucial to explore alternative healthcare options for the treatment of diabetes, especially at this time.

Documentation and conservation of traditional knowledge are essential for preserving traditional knowledge system (TKS), which eventually translate into valuable resources for drug discovery and new ideas. Traditional medicine, also known as folk medicine, is a system that has developed over generations within various civilizations, societies, communities, tribes and clans, spreading throughout India long before the advent of modern medicine. It is also referred to as complementary and alternative medicine, or ethnic medicine and continues to play a significant role in many countries today (3). Traditional medicines have been used for centuries across many countries worldwide. According to the World Health Organization in 2019, traditional medicine is estimated to constitute 65% to 80% of healthcare practices globally. The practice of folk healing and remedies has been integral to different ethnic communities in India, representing the oldest form of healthcare system used in the prevention and treatment of both physical and mental illnesses. It served as the primary healthcare delivery system prior to the introduction of modern medicines (3).

In North-East India, traditional knowledge permeates every aspect of life and encompasses a rich ecosystem biodiversity, which aids in solving everyday problems (4). As part of the northeastern region, the state of Nagaland is also blessed with abundant biodiversity and its communities possess unique folk healing practices (5). Ritualistic healing and folk remedies have been integral to various ethnic communities in Nagaland, including the Ao (Naga), Sümi, Angami, Chakhesang, Chang, Konyak, Kuki, Lotha, Phom, Pochury, Rengma, Sangtam, Tikhir, Yimkhiungand Zeme-Liangmai, since ancient times. Nagaland recognizes a total of 17 major Naga tribes, all of whom actively practice rich traditional healing methods (5).

Ao (Naga) is one of the recognized tribes in Nagaland and is settled in numerous villages within the Mokokchung district. Primarily agriculturists, they possess a wealth of traditional knowledge on the utilization of bio resources for their livelihood (7). The Ao (Naga) tribe practices traditional healing and folk medicine for the treatment of various ailments. In recent years, several researchers have contributed to the study of medicinal plants

diversity and traditional utilization patterns of plants in the Mokokchung district, Nagaland (8). However, there remains a gap in the documentation of medicinal plant diversity categorized by specific diseases. Therefore, the present study aims to document the traditionally used medicinal plant diversity specifically for the treatment of diabetes.

## Materials and Methods

### Study area

The Ao (Naga) tribe resides in the Mokokchung district, which is an important district of Nagaland covering an area of 1719 square kilometers. The district shares its borders with Jorhatin the north (Assam), Wokha in the west, Tuensang in the east, and Zunhebotoin the south (Fig. 1). Geographically, it is situated between 26°32" N and 94°51" E. The district's altitude ranges from 260 mts to 1463 mts above mean sea level. The district falls under Eastern Himalayan Region – North East Hills, experiencing sub-tropical and temperate climates. The study focused on the Ao (Naga) tribe and was conducted in various villages within the Mokokchung district. The region receives an average annual rainfall of 2500 mm. The Ao (Naga) tribe primarily resides on hilltops and utilizes plants from the nearby home forest to treat their medical conditions.

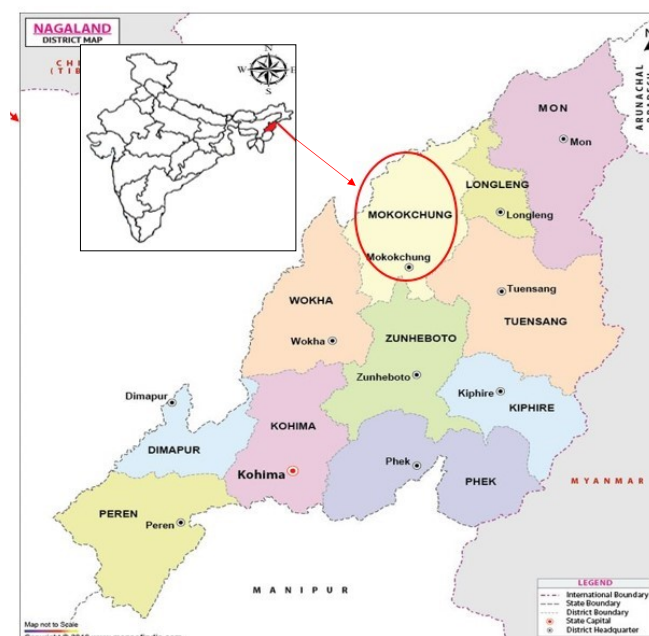


Fig. 1. Map showing the study site.

### Ethnobotanical survey

An ethnobotanical survey was conducted in the Mokokchung district among the Ao (Naga) tribe from 2021 to 2022. The survey encompassed various villages and seasons. Traditional healers were interviewed using a standardized questionnaire format, which involved personal and group discussions. The questionnaire included fields for recording the names of the traditional healers, local names of plants, plant parts used, preparation methods, dosage and mode of administration, source of plant collection, disease symptoms, dietary restrictions, number of

patients treated per year and knowledge acquired by the informants.

### Taxonomic identification of plant specimens

Plant specimens are identified using regional flora references (9) and the names were updated using World Flora Online (10). Herbarium specimens were prepared following standard methods of plant taxonomy (11) and stored in the Raw Drug and Herbarium (NEIAFMRH) of NEIAFMR, located in the Pasighat, Arunachal Pradesh.

### Data analysis

The data was organized and reviewed using an MS Excel sheet. Information on the plant species, including their scientific name, local name, family, parts used, voucher specimen number, preparation process, dose and mode of administration was recorded. Relative Frequency Citations (RFCs), Fidelity Level (FL) and Family importance Value (FIV) were also investigated (12-14).

### Relative Frequency of Citation (RFC)

The Relative Frequency of Citation signifies the importance of each species in the particular study area. This index theoretically varies from 0 to 1 and was calculated by using the following formula (12).

$$RFC = FC_s / N$$

Where, RFC= Relative Frequency Citation (It ranges from 0 to 1),  $FC_s$  = Number of informants who cited the use of a particular plant species and N = Total number of informants interviewed.

### Fidelity Level Percentage (FL %)

It measures certain plant species used by informants to treat particular ailments. The Fidelity Level Percentage (FL%) is calculated by the following formula (13).

$$FL(\%) = (N_p / N) \times 100$$

Where,  $N_p$ =Number of informants who independently claimed the use of a particular plant species for a particular ailment and N=Total number of informants who mentioned the plant species for any ailment.

### Family Importance Value (FIV)

Family Importance Value identifies the importance of plant families. FIV is calculated by the following formula (14).

$$FIV = FC_{family} / N \times 100$$

Where, FIV = Family Importance Value,  $FC_{family}$  = Number of informants mentioning the family and N = Total number of informants participated in the study.

## Results and discussion

### Demographic details of the informants

The current study identified 26 traditional healers, among whom 21 acquired their healing skills through familial transmission, while 5 learned them through self-interest. However, they possess extensive knowledge about the use of medicinal herbs for treating conditions such as diabetes and other illnesses. Interestingly, the younger generation, despite having higher education, appears to have less

information about the utilization of medicinal herbs. Among the healers, those aged over 70 exhibit the highest level of traditional knowledge and practices (38.46%), followed by the age groups of 61-70 (34.61%), 51-60 (19.23%) and 41-50 (7.69%). This pattern clearly indicates that older generations continue to rely on conventional medicine, while younger generations are less inclined towards its use. Therefore, systematic documentation and scientific validation of ethnomedicinal practices, along with their integration into the modern system of medicine, are important to conserve this traditional knowledge (Table 1).

**Table 1.** Demographic characteristics of the informants

Sl. no	Variable	Categories	No. of persons	Percentage
1	Gender	Male	19	73.08%
		Female	7	26.92%
		Below 40 years	Nil	00
		41-50 years	2	7.69%
2	Age group	51-60 years	5	19.23%
		61-70 years	9	34.61%
		Above 70 years	10	38.46%
		No formal education	6	23.077%
3	Education	Primary education	12	46.15%
		Secondary education	5	19.23%
		Graduate	3	11.53%
		Post graduate	Nil	00
		Traditional healer	14	53.84%
4	Profession	Farmer	7	26.92%
		Labour	5	19.23%
		Family inheritance	21	80.76%
5	Source of knowledge	Self interest	5	19.23%

### Diversity of medicinal plants

The present study recorded a total of 32 medicinal plants belonging to 26 families used for the management of diabetes among Ao (Naga) tribes (Supplementary Table 1). The Anacardiaceae family had the most species used, with 3, followed by Combretaceae, Zingiberaceae, Rutaceae and Caesalpiniaceae, each with 2 species, while other species were each represented by one each. The finding is also similar to the findings of another study, where they reported similar types of medicinal plants (15).

### Habit and habitat of medicinal plants

The study also examined the diversity of medicinal plant habits and found that herbs (14) had the highest usage for diabetes, accounting for 43.75% of the plants. This was followed by trees (11) at 34.37%, shrubs (5) at 15.62% and climbers (2) at 6.25% (Fig. 2). Among the 32 plants studies, 23 species were collected from their natural habitat, while 9 were cultivated (Fig. 3).

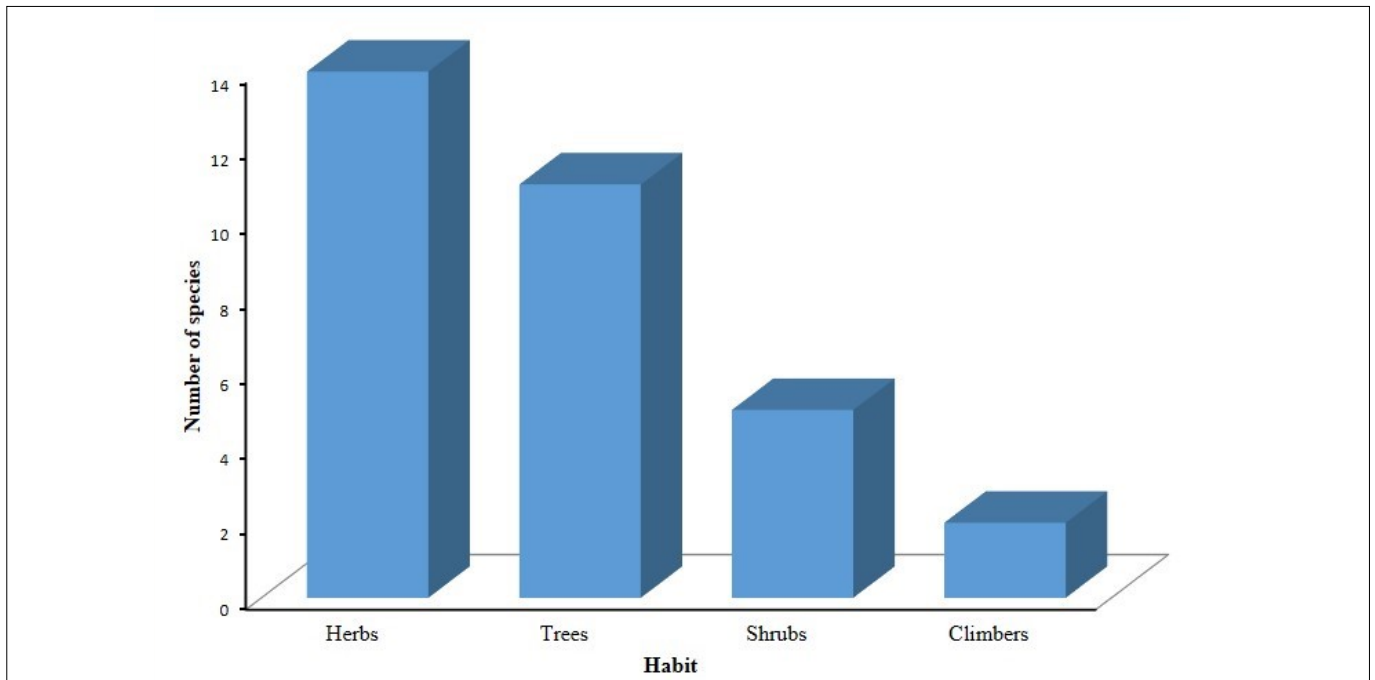


Fig. 2. Habits of medicinal plants used in the treatment of diabetes.

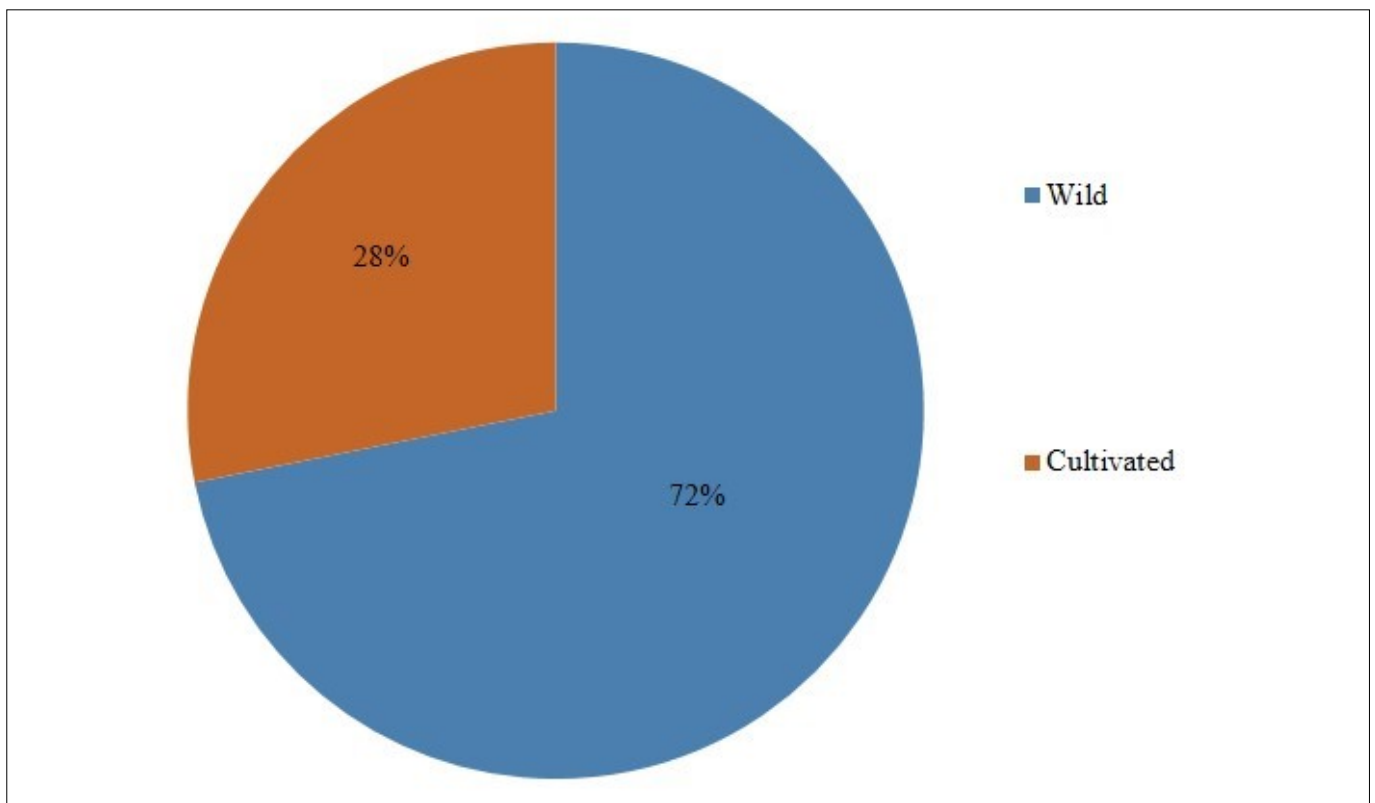


Fig. 3. Habitats of ethnomedicinal plants used in the treatment of diabetes.

**Plant parts used and methods of preparation of herbal drugs**

In the preparation of traditional medicines used for treating diabetes, traditional healers gather fresh parts. The most commonly used parts are the leaves (15), which account for 46.87% of the total weight of the plant, similar to findings in other investigations (16-18). This is followed by fruit (12) at 37.5% of weight and bark and rhizomes (2 of each species) at 6.25% each. The stem and bulbs (1 of each species) make up 3.12% of the total weight (Fig. 4).

Traditional healers commonly prescribe three types of traditional folk medicine: decoction, powder and extract (Fig. 5). Similar types of results were also found in other studies (16, 17). Out of the 32 formulations documented, 31 are monoherbal preparations, meaning they consist of a single medicinal plant, while 1 is a polyherbal medicine, which combines multiple medicinal plants. In addition to herbal ingredients, some folk medicines also incorporate certain minerals, such as black salt, in their preparation.

During the investigation, it was observed that patients receive doses of folk medicine based on their ages

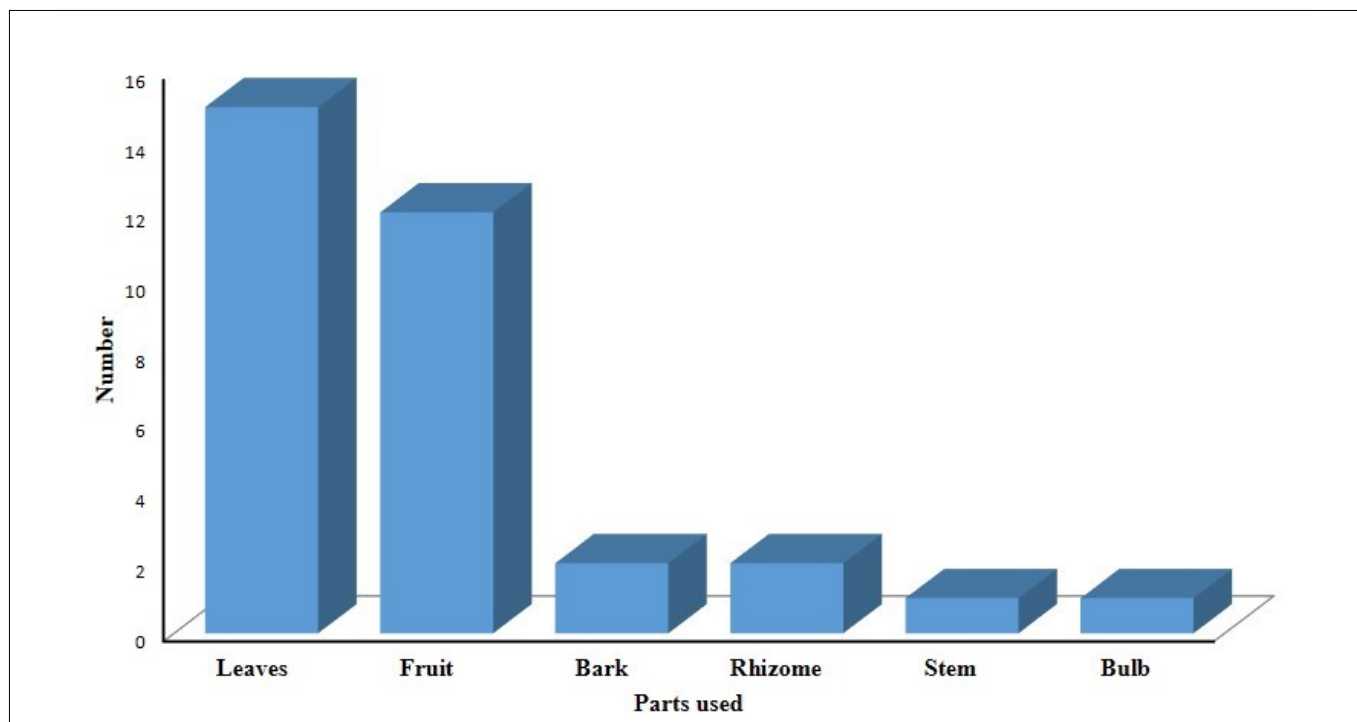


Fig.4. Plant parts used in the treatment of diabetes versus number of species.

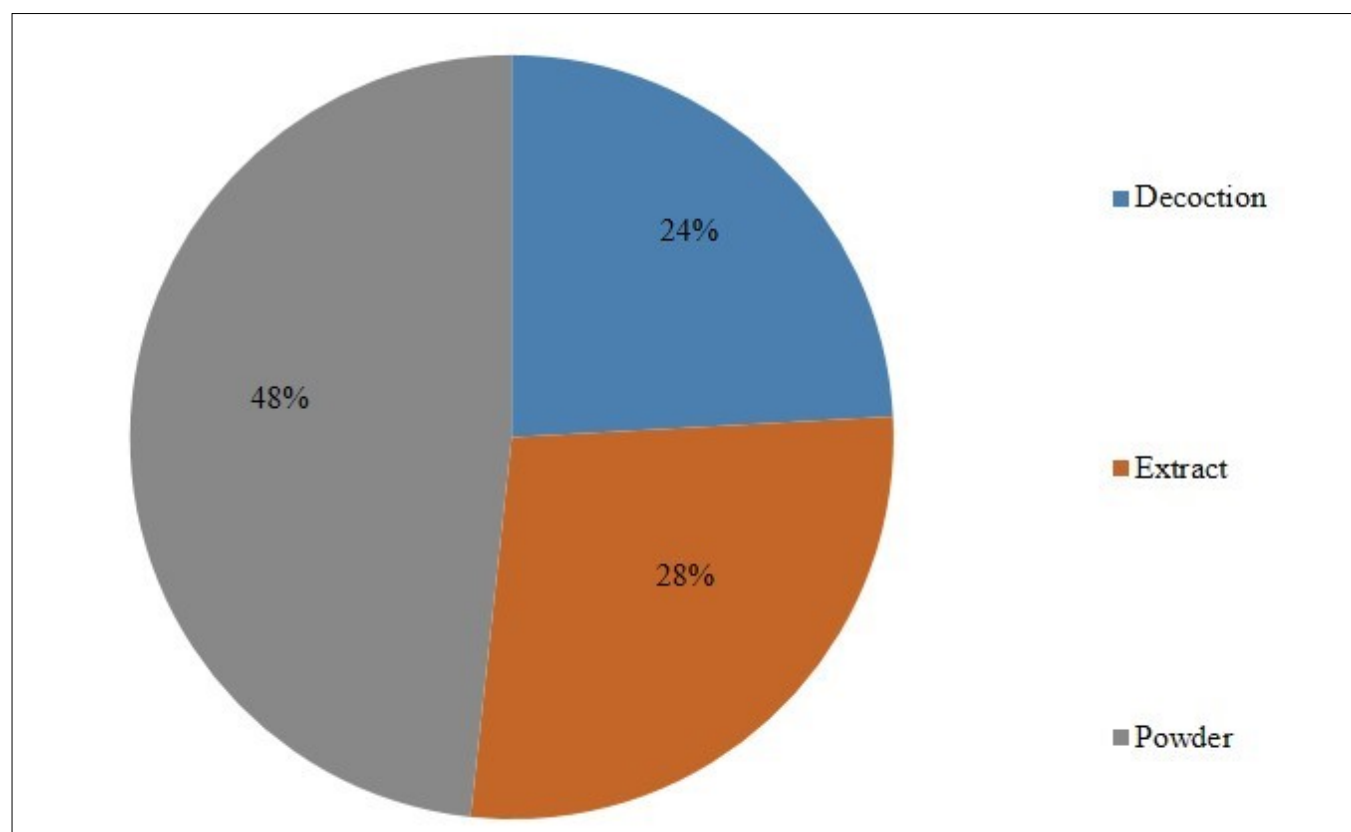


Fig. 5.Types of formulation used in the treatment of diabetes.

and symptoms. Typically, these medications are taken orally, either with meals or on an empty stomach as directed by the traditional healer.

#### Quantitative analysis

The relative frequency citation (RFC) values ranging from 0.07 to 0.96 were calculated and reported (Supplementary Table 1). Among the plant species, *Rhus semialata* Murr. had the highest RFC value (0.96), followed by *Clerodendrum colebrookianum* Walp (0.92), *Tinospora cor-*

*difolia* (Willd.)Miers ex Hook.f. & Thomson(0.88), *Gymnema sylvestre* (Retz.) R.Br. ex Sm. (0.84) and *Guilandina bonduc* L. (0.80). In Nagaland, *Rhus semialata*, being the most prevalent plant, is widely explored for its therapeutic applications, and many local folks utilize it to cure diabetes, similar to other findings (6). Plant species with high RFC values can be further investigated to explore their potential in the development of new herbal remedies.

Fidelity level (FL) is an index that indicates the im-

portance of a plant species in the aspect of traditional utilization (13). The fidelity level of all the reported species was calculated and presented (Supplementary Table 1). Among the plant species, *Allium sativum* L., *Cinnamomum tamala* (Buch.-Ham.) T.Nees & C.H.Eberm., *Citrus medica* L., *Clerodendrum colebrookianum* Walp., *Guilandina bonduc* L., *Ocimum basilicum* L., *Tinospora cordifolia* (Willd.)Miers ex Hook. f.& Thomson and *Momordica charantia* L. represent the plant species with 100% fidelity level, followed by *Garcinia pedunculata* Roxb. ex Buch.-Ham.(94.11%), *Gymnema sylvestre* (Retz.) R.Br. ex Sm.(91.66%), *Achyranthes aspera* L. (90.90%), *Curcuma caesia* Roxb.(86.36%) and other plant species showed the least fidelity level.

The family importance value of the reported species was analyzed and presented (Supplementary Table 1). In the present study, among the plant families, Anacardiaceae and Lamiaceae (84.61% each) represent the highest FIV, followed by Caesalpiniaceae, Gentianaceae, Menispermaceae (80.76% each), Acanthaceae (73.07%), Lauraceae (69.23%), Musaceae (69.23%) and the other family showed least FIV value. Similar results were found in other studies where it was reported that the Anacardiaceae and Lamiaceae families have been extensively utilized in traditional healing practices and possess a variety of biochemical substances with the greatest therapeutic capacities (19, 20).

## Conclusion

Traditional healing practices and folk medicine serve as an alternative system of medicine that efficiently manages the burden of Diabetes. In the present study, researchers observed that the Ao (Naga) tribe in the Mokokchung district of Nagaland mainly relies on ethnomedicine for treating diabetes. They employ 32 herbal formulations, prepared using distinctive methods based on practical experiences and traditional knowledge. These formulations have demonstrated effectiveness in managing diabetes. However, due to modernization and the availability of allopathic medicines, traditional healing practices and knowledge are gradually losing popularity, especially among the younger generation. Therefore, further scientific investigations are essential to validate the folk claims and traditional medicines used by the Ao tribe for the treatment of diabetes.

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## Authors contributions

JP carried out the fieldwork and drafted the manuscript. AB conceived of the study and supervised the work. GY, DT, IR, IM & RT participated in its design and coordination.

AB reviewed the manuscript. All authors read and approved the final manuscript.

## Compliance with ethical standards

**Conflict of interest:** Authors do not have any conflict of interest to declare.

**Ethical issues:** None.

## Supplementary data

Supplementary Table 1. Medicinal plants and their uses in the treatment of diabetes

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