

# Ethnobotanical Studies of Medicinal Plants Used in Managing Diabetes mellitus in Rejang Lebong Districts, Bengkulu - Indonesia

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**Abstract.** Diabetes mellitus is becoming a major cause of concern throughout the world. Many people, especially in rural communities, use medicinal plants to treat the disease and its complications. This study aimed to document the medicinal plant species used to manage diabetes mellitus and traditional knowledge of local communities in Curup Tengah, Rejang Lebong district, Bengkulu, Indonesia. This study was conducted using a semi-structured questionnaire targeting 32 diabetic patients, and 2 traditional healers. Twenty women (58.8%) and 14 men used medicinal plants to manage the disease. Furthermore, 44 plant species belonging to 34 botanical families were found. The Fabaceae family (9.1%) contributes the highest number of medicinal plant (4 species) followed by Zingiberaceae (3 species) and Asteraceae (2 species). Leaves (38.63%), fruit (18.18%), and seeds (13.36%) were the predominant parts used to prepare the medicine through the extraction method. Documentation of medicinal plants used to treat diabetes as a foundation for subsequent scientific research, with a focus on plants with a high level of informant consensus. Plants with low UV levels, on the other hand, need bioactive screening to confirm their use for the condition. This could be interpreted as a sign of potential plants for the discovery of novel medications. *Smallanthus sonchifolius* and *Anredera cordifolia* are reported for the first time as being used in the traditional treatment of diabetes in this study.

**Key words:** Diabetes mellitus; traditional medicinal plants; Rejang Lebong

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## INTRODUCTION

Diabetes mellitus is a global health concern because it remains incurable and continues to increase worldwide. The International Diabetic Federation (IDF) report shows a continuous rise in its prevalence in recent decades (Ogurtsova et al., 2017). Diabetes is predicted to affect 463 million people worldwide in 2019, accounting for 9.3% of the global adult population (20–79 years). In 2030, this number is predicted to rise to 578 million (10.2 percent) and 700 million (10.9 percent) by 2045. Diabetes is predicted to affect 9.0 percent of females and 9.6 percent of males in 2019. Diabetes prevalence rises with age, with a prevalence of 19.9% (111.2 million) in adults aged 65 to 79 years (Saedi, et al., 2019).

This metabolic disease is identified by high blood glucose levels due to an abnormality in insulin secretion, insulin action, or both (Khan et al., 2009). Microvascular (retinopathy, neuropathy, and nephropathy) and macrovascular (heart attack, stroke, and peripheral vascular disease) complications plague people with this condition, increasing morbidity and mortality (Jarald et al., 2008).

The diabetes mellitus management remains a global issue, and the effective treatment has not yet

been discovered. Nevertheless, many drugs have been developed and used globally. The allopathic medicines used for the treatment of diabetes included insulin and anti-diabetic drugs (Rao & Sreenivasulu, 2010). Although insulin and hypoglycemic drugs are currently admitted as the most effective treatment, they may cause various complications, including increased lipid reserves, shrinkage at the injection site, and hypoglycemic shock (Gumprecht & Nabrdalik, 2016). Furthermore, a small number of traditional medications are known to have severe toxicity, as well as high cost and unavailability. The summit of the World Health Organization (WHO) advocated the assessment of medicinal plants (MP) according to their efficacy, cost, and the presence of small or no side effects (Day, 1998). Recently, there have been increasing efforts to use an alternative agent such as herbal medicines. In fact, the use of medicinal plants has resulted in a reduction in the incidence of various diseases due to the protective effect against oxidative damage and the ability in lowering inflammation (Nasri et al., 2013). Furthermore, plants are respected as an essential substitute to develop novel medicines beneficial in the treatment. This applies not only to active chemicals, but also to their overall acceptance for use.

WHO data shows that about 70% to 95% of people use traditional medicines for basic health care (WHO, 2019). Hence, herbal medicine presents an essential function in diabetic therapy, particularly in developing countries where the largest population are resource-poor and have small or no access to advanced treatment (Ajaiyeoba et al., 2006). In Indonesia, several plants have medicinal characteristics and are used to cure a variety of ailments (Salim & Munadi, 2017). Furthermore, several are used as spices, food, and medicinal plants (Silalahi & Nisyawati, 2018). According to the

Badan Penelitian dan Pengembangan Kesehatan (2013), the prevalence of this disease is 1.5%. Meanwhile, regarding the national majority, Bengkulu Province has about 0.9%. Furthermore, the number of cases in Rejang Lebong District was 183, according to the Bengkulu Provincial Health Office in 2016. Because of the high prices, lack of availability, and inaccessibility associated with allopathic treatment of hyperglycemia, diabetic patients and traditional healers are increasingly interested in complementary and alternative medicine. Despite the widespread use of medicinal plants for a variety of therapeutic purposes, little research has been done on herbal medicines. Therefore, this study aimed to document the medicinal plant species used to manage diabetes mellitus and the ethnobotanical knowledge of local communities in Curup Tengah, Rejang Lebong district, Bengkulu, Indonesia. The purpose of this research is to learn as much as possible about medicinal plants that have traditionally been used in diabetes treatment in the Rejang Lebong district. We seek to promote the safe and effective use of these herbs for therapeutic purposes, based on pharmacological data.

## METHODS

### Study area

The study area was 102°19' and 102°57' East Longitude and between 2°22'07" and 3°31' South Latitude. The annual average rainfall was 233.75 mm, and the temperature differ from an average yearly lowest of 18°C to a peak of 31°C. This district had an area of 1.515.76 km<sup>2</sup> and a population of about 257,498 people. Furthermore, it was positioned on the slopes of the Bukit Barisan mountains and 85 km from Bengkulu city, the provincial capital. In addition, the indigenous people consisted of 2 main tribes, namely Rejang and Lembak tribes (Fig.1) (Ilyas & Abudzar, 2019).

### Ethnobotanical survey

The data were obtained by direct interaction with the diabetic patients who used these medicines and the traditional healers. The inclusion criteria for selecting the population were guided by Cohen et al. (2000). Based on Cohen et al (2000), the minimum sample size is 30 respondents. The data collection used a semi-structured questionnaire and a guided field walk with traditional healers.



Figure 1. The study area map

In the guided field walk method, an interview was conducted in the local language, which was the language spoken and understood by traditional healers and the local people. The interviews were carried out during the day and were designed to record the information of plants used to treat diabetes, their local names, preparation methods, the parts used, and mode of administration. The documented plant samples were dried, stored, and identified by a plant taxonomist.

### Botanical identification

Traditional healers assisted in the collection of therapeutic plants from natural vegetation (forests) or household gardens. The botanical identities of the specimens gathered were verified by the authors and other taxonomists at Nasional University, Biology Faculty, Indonesia. Plant names were checked with the Plant List ([www.plantlist.org](http://www.plantlist.org)) and International Plant Names Index ([www.ipni.org](http://www.ipni.org)).

### Data analysis

Fidelity Level (FL) and Use Value (UV) indices were used to examine the ethnobotanical data collected (UV). This established a consensus on the effective species for curing diabetes and their relative importance. Also, it facilitated the understanding on the potential usefulness of each species.

### Fidelity Level

The Fidelity Level (FL) indicates the percentage of informants that use utilize a certain plant species for the same principal function as in the equation below:

$$N_p/N \times 100 = \text{FL (percentage).}$$

$N_p$  is the number of informants that used a plant species to treat a particular disease, and  $N$  is the number that used plants as a medicine to treat various diseases (Friedman et al., 1986).

### Use Value (UV)

Use Value (UV) is an index in ethnobotany that has been widely used to quantify the relative importance of useful plants, and proves the relative significance of locally known plants as expressed in the following equation (Gazzano et al., 2005):

$$UV = \frac{\sum U_i}{N}$$

$U_i$  is the number of usages each informant stated for a given species, and  $N$  is the total number of informants.

## RESULTS AND DISCUSSION

### Ethnobotanical survey

This study showed medicinal plants still play an important role in primary health care. Twenty women

(58.8%) and 14 men used medicinal plants to manage the diseases. During the survey, it was recognized that more than 70% of the people frequently used medicinal plants for various diseases, including diabetes. This could be due to their accessibility. The most widely used medicinal plant in Rejang Lebong were obtained from cultivated herbs which constituted the highest category of 15 species (36%).

A total of 44 plants from 34 families were reported as being used for managing diabetes in Rejang Lebong. Fabaceae, Zingiberaceae, and Asteraceae were the most commonly stated plant families, while leaves, fruits, and seeds were the most frequently used parts (Table 1). Other ethnobotanists reported similar results. Furthermore, Malini et al. (2017) reported that the families of Zingiberaceae, Fabaceae, Asteraceae, and Euphorbiaceae were considered as the highest number of Karangwangi medicinal plants probably due to their high species and their compositions of secondary metabolites (Malini et al, 2017).

**Table 1.** The plant used for the treatment of diabetes mellitus in Rejang Lebong

Scientific name/ Local name	Family	Part used	Method of preparation	UV	FL (%)
<i>Andrographis paniculata</i> Ness/Sambiloto	Acanthaceae	Leaf	Decoction	0.38	31.2
<i>Aloe vera</i> L./ /Lidah buayo	Asphodelaceae	Leaf	Decoction	0.06	10.4
<i>Annona muricata</i> L./ Nangko belando	Annonaceae	Leaf	Decoction	0.38	26.0
<i>Anredera cordifolia</i> (Ten.) Steenis/Binahong	Basellaceae	Leaf	Decoction	0.38	52.0
<i>Archidendron pauciflorum</i> /Jengkol	Fabaceae	Seed	Direct consumption	0.13	21.0
<i>Areca catechu</i> L./Pinang	Arecaceae	Fruit	Decoction	0.18	21.0
<i>Artocarpus altilis</i> (Park.) Fosberg/Sukun	Moraceae	Fruit	Extraction of juice	0.18	26.0
<i>Averrhoa carambola</i> L./ Belimbing besi	Oxalidaceae	Fruit	Direct consumption	0.18	10.4
<i>Carica papaya</i> L./ Kates	Caricaceae	Leaf	Decoction	0.38	26,0
<i>Catharanthus roseus</i> (L.) Don./ Tapak Darah	Apocynaceae	Leaf	Decoction	0.38	21.0
<i>Cinnamomum verum</i> J. Presl./ Kayu Manis	Lauraceae	Stem, bark	Decoction	0.06	26.0
<i>Colocasia esculenta</i> (L.) Schott./ Ubi keladi	Araceae	Tuber	after cooking, as a meal	0.04	21.0
<i>Cucurbita maxima</i> L./ Perenggi	Cucurbitaceae	Seed	Decoction	0.13	10.4
<i>Curanga fel-terrae</i> (Lour.) Merr./ Punguntano	Scrophulariaceae	Leaf	Decoction	0.38	5.2
<i>Curcuma longa</i> L./ Kunyit	Zingiberaceae	Rhizome	Decoction	0.06	26.0
<i>Curcuma xanthorrhiza</i> Roxb./ Temulawak	Zingiberaceae	Rhizome	Decoction	0.06	15.6
<i>Garcinia mangostana</i> L./ Manggis	Clusiaceae	Fruit	Infusion	0.06	36.4
<i>Glycine max</i> (L.) Merr./ Kedelai	Fabaceae	Seed	Decoction	0.13	21.0
<i>Hibiscus sabdariffa</i> L./ Bungo rose	Malvaceae	Flower	Decoction	0.04	10.4
<i>Ipomoea batatas</i> (L.) Lam./ Ubi tanah	Convolvulaceae	Tuber	after cooking, as a meal	0.04	10.4

<i>Lansium domesticum</i> Corr./ Langsat	Meliaceae	Leaf	Decoction	0.38	10.4
<i>Leucaena leucocephala</i> (Lam.) de Wit/ Pete cino	Fabaceae	Seed	Direct consumption	0.13	31.2
<i>Malus domestica</i> Borkh./ Apel	Rosaceae	Fruit	Direct consumption	0.18	10.4
<i>Mangifera indica</i> L./ Mangga	Anacardiaceae	Leaf	Decoction	0.38	10.4
<i>Momordica charantia</i> L./ Pare	Cucurbitaceae	Fruit	Extraction of juice	0.18	26.0
<i>Morinda citrifolia</i> L./ Mengkudu	Rubiaceae	Fruit	Extraction of juice	0.18	26.0
<i>Muntingia calabura</i> L./ Ceri	Muntingiaceae	Leaf	Decoction	0.38	93.8
<i>Musa acuminata</i> Colla/ Pisang	Musaceae	Flower	Decoction	0.04	10.4
<i>Ocimum basilicum</i> L./ Kemangi	Lamiaceae	Leaf	Direct consumption	0.38	21.0
<i>Orthosiphon aristatus</i> (Blume) Miq./ Kumis kucing	Lamiaceae	Leaf	Decoction	0.38	31.2
<i>Oryza nivara</i> L./ Beras Merah	Poaceae	Seed	after cooking, as a meal	0.13	41.6
<i>Phaleria macrocarpa</i> (Scheff.) Boerl./ Mahkota Dewa	Thymelaeaceae	Fruit	Decoction	0.18	36.4
<i>Physalis angulata</i> L./ Celetup	Solanaceae	Fruit	Direct consumption	0.18	21.0
<i>Piper crocatum</i> Ruiz & Pav./ Sirih merah	Piperaceae	Leaf	Decoction	0.38	36.4
<i>Coleus scutellarioides</i> (L.) Benth./ Adong – adong	Lamiaceae	Whole plant	Decoction	0.06	10.4
<i>Psidium guajava</i> L./ Jambu batu	Myrtaceae	Leaf	Decoction	0.38	10.4
<i>Stachytarpheta mutabilis</i> (Jacq.) Vahl./Ngokilo	Verbenaceae	Leaf	Direct consumption	0.38	10.4
<i>Swietenia macrophylla</i> King/Mahoni	Meliaceae	Seed	Infusion	0.13	15.6
<i>Syzygium polyanthum</i> (Wight) Walp/Salam	Myrtaceae	Leaf	Decoction	0.38	15.6
<i>Smallanthus sonchifolius</i> (Poepp.& Endl.) H. Robinson/Insulin	Asteraceae	Leaf	Decoction	0.38	78.0
<i>Tinospora cordifolia</i> (Willd.) Hook.f./ /Brotowali	Menispermaceae	Whole plant	Decoction	0.06	31.2
<i>Vernonia amygdalina</i> Del./Daun Afrika	Asteraceae	Leaf	Decoction	0.38	15.6
<i>Vigna cylindrica</i> (L.) Skeels/Kacang Panjang	Fabaceae	Fruit	Decoction	0.18	21.0
<i>Zingiber officinale</i> L./Jahe	Zingiberaceae	Rhizome	Decoction	0.06	15.6

Note: UV = Use Value; FL = Fidelity Level

This study reported 44 anti-diabetic medicinal plants. This is higher than the study by Simanjuntak (2018) in an ethnobotanical survey on the anti-diabetic medicinal herbs in Simalungun ethnic, North Sumatra, Indonesia that obtained 26 species. This is also higher than the study by Ocvirk et al. (2013) in Pakistan, Amal et al. (2016) in Saudi Arabia, and Skalli et al. (2019) in Morocco reporting 37, 20, and 30 anti-diabetic plant species respectively. The high number of anti-diabetic plants included in this study reflects the species diversity in the area. Vandebroek et al. (2004) showed that the population knowledge demonstrates the wealth of vegetation they live in. In addition, it was asserted that the richer the vegetation,

the more it offers diverse species. Some of the plant species recognized were also studied by indigenous people of Pakistan, Nigeria, and India for the identical purpose. The plants include *Andrographis paniculata*, *Mangifera indica*, *Momordica charantia*, *Ocimum sanctum* (Ocvirk et al., 2013), *Aloe vera*, *Carica papaya*, *Hibiscus sabdariffa*, *Zingiber officinale* (Kadiri et al., 2015), and *Curcuma longa* (Skalli et al., 2019). Therefore, these species could be recognized as promising candidates for further scientific validation in searching for new, effective, and affordable anti-diabetic medicines.

The anti-diabetic activity of some plant species stated has been experimentally described in the *in*

*vivo* and *in vitro* diabetic models. The plants include *Andrographis paniculata* (Akhlar et al., 2016), *Mangifera indica* (Ngo et al., 2019), *Momordica charantia* (Mahmoud et al., 2017), *Ocimum sanctum* (Raja et al., 2016), *Aloe vera* (Ramirez et al., 2020), *Carica papaya* (Maniyar & Bhixavatimah, 2013), *Hibiscus sabdariffa* (Wang et al., 2011), *Zingiber officinale* (Li et al., 2012) and *Curcuma longa* (Lekshmi et al., 2014).

Table 2 lists the key phytochemical substances found in references to be useful in the treatment of diabetes mellitus for the most often utilized plant species. It was obvious from the obtained data that phenolic compounds could represent the main effective group of secondary metabolites in the treatment of the disease and in managing the effects of its complications



*Muntingia calabura*



*Smallanthus sonchifolius*



*Anredera cordifolia*

**Figure 2.** The most commonly used plants in the treatment of diabetes in Rejang Lebong

**Table 2.** Main phytochemical compound identified in the most commonly used plant species in the treatment of diabetes

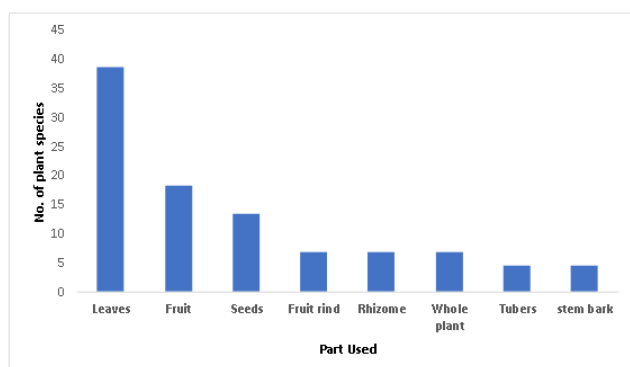
Plant species	Phytochemical compound	References
<i>Andrographis paniculata</i>	Trans-cinamic acid (polyphenol)	Tan et al. (2016)
<i>Mangifera indica</i>	Hydroxybenzoid (phenolic acid)	Maldonado-Celis et al. (2019)
<i>Momordica charantia</i>	Catechin (polyphenol)	Jia et al (2017)
<i>Ocimum sanctum</i>	Eugenol (essential oil)	Bano et al. (2017)
<i>Aloe vera</i>	Cinnamic acid (phenolic compound)	Quispe et al. (2018)
<i>Carica papaya</i>	Caricapapayol (Phenolic)	Kim Lien et al. (2019)
<i>Hibiscus sabdariffa</i>	Protocatechuic acid (phenolic acid)	Da-Costa- Rocha et al. (2014)
<i>Zingiber officinale</i>	Zingerone (Phenolic)	Mao et al. (2019)
<i>Curcuma longa</i>	Curcumin (phenolic)	Li et al. (2011)

### Characteristic of medicinal plant preparation

The recipes are usually made from a single plant part. Decoction is the most selected method of preparation, while oral route was the only mode of administration. Leaves are the most commonly used

part for managing diabetes, followed by the fruits and seeds (Fig.3). The use of leaves could be attributed to the presence of high amount of chemical compounds, which could be easily extracted and used in different forms (Imran et al., 2014). Also, Furthermore,

traditional healers prefer to pick wild plants since they have a higher concentration of medicinal components when harvested in their original habitat (Ngobula et al., 2014). In addition, the use of leaves is less dangerous to the plant life compared to using the root, stem, bark, or whole plant (Zheng & Zing, 2009).



**Figure 3.** The different organs used of identified anti-diabetic plants

#### Fidelity Level index (FL)

Fidelity level (FL) is valuable in determining the level of species relevance concerning a particular disease (Khan et al., 2014). Furthermore, FL shows the proportion of respondents who said they utilized the same plant species for the same purpose. This is important to determine which species is effective for a particular disease. The results showed that the FL value of the 44 plant species ranged from 5.2 to 93.8% (Table 1). *Muntingia calabura* showed the highest FL (93.8%), followed by *Smallanthus sonchifolius* (78%), and *Anredera cordifolia* (52%). Also, a prior research showed that plants with a high percentage of FL are more commonly used as biopharmacological sources (Ahmad et al., 2017) and should be considered for further bioassays and phytopharmacological research (Hassan-Abdallah et al., 2013; Kayani et al., 2015). The high FL plants might be selected for additional chemical screening to investigate the bioactive compounds responsible for the good curative potential (Lulekal et al., 2013).

Some species that possess a low percentage of FL (5.2 to 10.4%) included *Aloe vera*, *Averrhoa carambola*, *Coleus scutellaroides*, *Cucurbita maxima*, *Curanga fel-terrae*, *Hibiscus sabdariffa*, *Ipomea batatas*, *Lansium domesticum*, *Malus domestica*, *Mangifera indica*, *Musa acuminata*, *Psidium guajava*, and *Stachytarpheta mutabilis*. The low fidelity levels also show the low abundance of plant species. This may reveal some information regarding medicinal plant use among the people of Curup Tengah, Rejang Lebong district. Moreover,

even though some plants occupy low FL, they should not be discarded from the list to maintain the traditional knowledge of the community in diabetes treatment (Chaachouay et al., 2019).

#### The UV values of medicinal plants and their diversity

The use-value (UV) was determined based on the informants' citations for specific medicinal plants, and its value was determined based on the informants' citations for specific medicinal plants, and the value varied from 0.04-0.38 (Table 1.). This study showed that *Andrographis paniculata*, *Annona muricata*, *Anredera cordifolia*, *Carica papaya*, *Catharanthus roseus* *Curanga fel-terrae*, *Lansium domesticum*, *Mangifera indica*, *Muntingia calabura*, *Ocimum basilicum*, *Orthosiphon aristatus*, *Piper crocatum*, *Psidium guajava*, *Stachytarpheta mutabilis*, *Syzigium polyanthum*, *Smallanthus sonchifolius*, and *Vernonia amygdalina* exhibited a higher UV (0.38), followed by *Areca catechu*, *Artocarpus altilis*, *Averrhoa carambola*, *Malus domestica*, *Momordica charantia*, *Morinda citrifolia*, *Phaleria macrocarpa*, *Physalis angulata*, and *Vigna cylindrica* (UV=0.18), *Archidendron pauciflorum*, *Cucurbita maxima*, *Glycine max*, *Leucaena leucocephala*, *Oryza navira*, and *Swietenia macrophylla* (UV=0.13). The least UV was exhibited by 2 plant species (UV = 0.04 each). These species had the highest UV index because a large number of informants noticed them. The species with high UV needs further assessment to analyze their phytochemical and pharmaceutical properties. It is used to identify their active constituents for drug extraction (Vitalini et al., 2013). In addition, because of their high utilization, the species should be prioritized for conservation because over-harvesting may represent a threat to their population.

Based on the highest index of Fidelity Level (FL) and UV, *Muntingia calabura*, *Smallanthus sonchifolius*, and *Anredera cordifolia* may be used for further pharmacological studies to discover the new drugs. Further characterization of the active compounds, efficacy, evaluation of the mechanism of action and toxicity of these medicinal plants may be an efficient and cost-effective way to control diabetes mellitus. We hope that in this manner the therapeutic potentials of these medicinal plants can be harnessed towards a possible integration into the healthcare system. The novelty of this study is *Smallanthus sonchifolius* and *Anredera cordifolia* are reported for the first time as used in the traditional treatment of diabetes.

## CONCLUSION

This study has revealed important information on medicinal plants used by people and traditional healers of Rejang Lebong district, Bengkulu, Indonesia to treat diabetes. It is also demonstrated the vital role that medicinal plants play in the primary healthcare of these people. Forty-four plant species, belonging to 34 families are used by people of Rejang Lebong district to treat diabetes. Documentation of medicinal plants used to treat diabetes as a foundation for subsequent scientific research, with a focus on plants with a high level of informant consensus. Nevertheless, plants that achieved low UVs also need bioactive testing to confirm their efficacy in treating the condition.

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