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Ethnobotanical Study of Medicinal Plants for Diabetes Mellitus in the Sanggabuana Area, Karawang, West Java

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Abstract

Indonesia is the second richest country in terms of biodiversity, particularly in plant species. Generally, the community utilizes plants for traditional medicinal purposes, which is the essence of the field of Ethnobotany. This research aims to identify plants with the highest Use Value (UV) and Fidelity Level (FL) in the local community for treating Diabetes Mellitus (DM). The study was conducted in the Sanggabuana Conservation Foundation area, Karawang, West Java. The methodology involved field observation, interviews, plant identification, and documentation of medicinal plants and residents during interviews. The research revealed that plants with the highest Use Value (UV) were *Solanum torvum* (tekokak) and *Physalis angulata* (ciplukan) at 5.26%. The plant with the highest Fidelity Level (FL) for treating Diabetes mellitus was *Moringa oleifera* (kelor) with a value of 10.53%. *Moringa oleifera* can be used as a medicinal plant for Diabetes mellitus due to its phytochemical content, such as flavonoids that function as antidiabetics. The parts of the moringa plant used are the leaves, and the processing method involves boiling.

Keywords: Diabetes Melitus, Fidelity Level, Sanggabuana, Use Value

INTRODUCTION

Indonesia is the second richest country in terms of biodiversity. There are approximately 30,000 plant species in Indonesia, and 7,000 of them are known for their medicinal properties (Widyawati and Wulandari, 2018). Indonesia stands as the region with the highest number of medicinal plants in Asia, with around 90% of these plants thriving in the country (Tilaar et al., 2010). The utilization of medicinal plants as part of a self-care treatment system is common among the community, particularly in rural and remote areas of Indonesia (Rahayu et al., 2021). As reported by Tilaar et al. (2010), approximately 940 species of medicinal plants have been used by the Indonesian people.

The Sanggabuana community still extensively utilizes plants as herbal medicine to treat various illnesses. This is attributed to several factors. Firstly, medicinal plants are easily accessible in their surroundings or in the nearby forests. Secondly, the remote location of the

area from cities and the limited availability of healthcare facilities mean that acquiring medicines takes a considerable amount of time. Thirdly, from an economic perspective, traditional medicines are relatively more affordable and can even be obtained for free without incurring expenses. In contrast, modern medicines are more expensive, making them unaffordable for individuals with lower income levels (Hasanuddin and Kusyanti, 2016).

Karawang is one of the regions that possesses fertile land in West Java, so a significant portion of its land is utilized for agriculture. According to Azhari et al. (2021), in the year 2020, the total area of Karawang Regency was 1,752.59 km² or 175,259 hectares, with paddy fields covering approximately 95,906 hectares or 55%. Administratively, this area consists of 30 sub-districts, 297 villages, and 12 urban villages (PERDA, 2014).

According to the West Java Regional Health Office (2020), a prevalent disease among the population, particularly in Karawang Regency, is Diabetes mellitus (DM), based on the calculation of the number of diabetes sufferers in Karawang Regency, which has reached 77,514 individuals, 1.4% of whom are still adolescents (Faqih, 2023). Diabetes Mellitus (DM) is a metabolic disorder characterized by hyperglycemia (high blood glucose levels) due to insulin deficiency, insulin resistance, or both (Piero et al., 2014). DM is known as a silent killer because it often goes unnoticed by the affected individuals, and complications may already have occurred by the time it is diagnosed (Kemenkes RI, 2014). DM can affect almost every system in the human body, from the skin to the heart, leading to complications.

Diabetes Mellitus is generally divided into two types, namely Type 1 Diabetes Mellitus and Type 2 Diabetes Mellitus. In Type 1 DM, insulin hormone is not produced due to damage to the pancreatic β cells, while in Type 2 DM, there is a progressive disorder of insulin secretion by pancreatic β cells and a decrease in insulin sensitivity in its target tissues (Bharti et al., 2018). Type 2 diabetes is characterized by abnormalities in insulin secretion and insulin function caused by a combination of genetic factors related to insulin secretion disorders, insulin resistance, and environmental factors such as obesity, overeating, undernutrition, lack of exercise, stress, and aging, which can affect various human organ systems over a specific period, known as complications (Ozougwu et al., 2013).

Individuals with DM have a high risk of experiencing complications such as blindness, kidney failure, heart attacks, and strokes (Devi, 2019). To avoid complications, individuals with diabetes typically seek treatment with minimal side effects. Traditional herbal plants become a common choice for treating DM because many plants have been proven to be effective in lowering blood sugar levels. According to Sholih et al. (2021), sambiloto (*Andrographis paniculata)* and turmeric rhizomes can be used as herbal remedies for diabetes. Jafri et al. (2010) reported that administering ginger extract to rats injected with alloxan could lower blood glucose levels.

Based on the background, it is necessary to conduct an ethnobotanical study of medicinal plants aimed at determining and identifying the types of plants used as Diabetes Mellitus (DM) remedies and their processing methods by the community in Sanggabuana, Karawang, West Java. The calculation of UV (Use Value) and FL (Fidelity Level) is carried out to ascertain which plants are widely used and hold the highest level of trust among the community in treating Diabetes Mellitus (DM).

METHOD

Study area

The present study was conducted in Sanggabuana Conservation Area, Karawang, West Java.

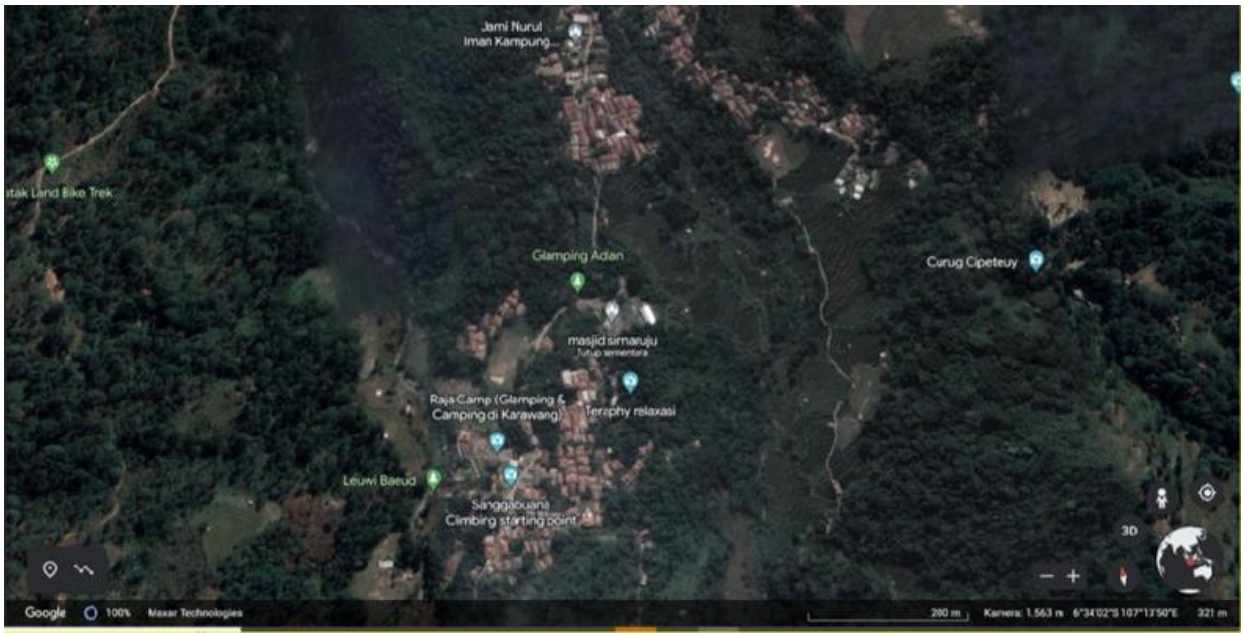

Figure 1. Map of the study area

Data Collection

Field work was carried out from 10 to 15 September 2023. A total of 38 (28 females and 10 males) informants were interviewed in the study area, in which all informants were selected purposively and systematically based on recommendation of knowledgeable elders, local authorities. All of informants were local inhabitants. Traditional healers were surely identified as key informants, because they were important custodians and participants of indigenous knowledge of medicinal plants. Interestingly, all these traditional healers were females. A few males were also interviewed to examine their medicinal knowledge and opinions. Ethnobotanical investigations were carried out to collect data on medicinal plants used to treat Diabetes mellitus. The methodological approaches were semi-structured interviews, field observation and guided field walks. Information was carefully recorded during interviews with

each informant. Field observation were performed with traditional healers guided on the morphological features and and habitats of each medicinal plant species. The information obtained was cross-checked with the other informants. The list medicinal plants were collected from field and gardens.

Data analysis

The ethnobotanical data generated were analysed using quantitative indices, namely Fidelity Level (FL) and Use Value (UV). This helped to establish a consensus on which species are effective to cure diabetes, as well as the species relative importance, and enables us to understand the extent of the potential utilization of each species.

Fidelity Level

FL indicates the percentage of informants claiming the use of a certain plant species for the same major purpose. Fidelity level is calculated by the following formula:

$$FL(\%) = \frac{Np}{N} \text{x } 100$$

Np is the number of informants that claimed a use of a plant species to treat a particular disease and N is the number of informants that used plants as a medicine to treat any given disease (Friedman et al., 1986).

Use Value (UV)

Use value (UV) demonstrates the relative importance of plants known locally. It was calculated using the following formula (Gazzano et al., 2005)

$$UV = \frac{\sum UVis}{ni}$$

Where UV is the number of uses mentioned by each informant for a given species and ni is the total number of informants.

RESULT

Medicinal Plants for Antidiabetes.

Diabetes mellitus (DM) or diabetes is a disease caused by disturbances in pancreatic metabolism. Diabetes mellitus is generally characterized by an increase in blood sugar levels,

also known as hyperglycemia, resulting from a decrease in the amount of insulin (Lestari et al., 2021). DM can be exacerbated by oxidative stress, especially if the endogenous antioxidant capacity is not strong enough to withstand free radical attacks (Bartosikova et al., 2003). Diabetes mellitus is classified as a degenerative disease that cannot be cured, but it can be alleviated through therapy or the use of specific medications (Isniati, 2007).

Based on the interview results with residents of Sanggabuana Village, there are several medicinal plants commonly used in managing Diabetes Mellitus. There are 26 species of medicinal plants listed in Table 2, including *Achillea millefolium* L (Thousand Leaves), *Areca catechu* (Betel Nut), *Centella asiatica* (Gotu Kola), *Chromolaena odorata* (Siam Weed), *Cocos nucifera* L (Coconut), *Cordyline fruticosa* (Ti Plant), *Crescentia cujete* (Calabash), *Dendrocnide stimulans* (Cowitch), *Graptophyllum pictum* (Caricature Plant), *Gynura procumbens* (Longevity Spinach), *Hemigraphis colorata* (Red Ivy), *Imperata cylindrica* (Cogon Grass), *Melia azedarach* (Chinaberry), *Mimosa pudica* (Sensitive Plant), *Moringa oleifera* (Moringa), *Muntingia calabura* (Jamaican Cherry), *Orthosiphon aristatus* (Cat's Whiskers), *Physalis angulata* L (Ciplukan), *Ruellia tuberosa* L (Wild Petunia), *Sandoricun koetjape* (Kecapi), *Staurogyne elongata* (Star Grass), *Smallanthus sonchifolius* (Yacon), *Solanum torvum* (Turkey Berry), *Strobilanthes crispus* (Java Tea), *Syzygium polyanthum* (Indonesian Bay Leaf), and *Zingiber cassumunar* (Cassumunar Ginger). Most local residents tend to utilize these medicinal plants by boiling them, while other methods of administration include consuming them directly, grating and boiling, and drying them before boiling.

The plants generally contain compounds from the flavonoid group, such as quercetin, kaempferol, and resin, where these compounds are commonly found in various plants (Ajie, 2015). According to Ajie (2015), flavonoid compounds can be used as hypoglycemic agents, as they can protect pancreatic β cells, which produce insulin, and enhance insulin sensitivity as antioxidants (Ruhe, 2001). Flavonoid compounds are known to reduce blood sugar levels by inhibiting the α-glucosidase enzyme, which plays a role in breaking down carbohydrates into glucose (Novalinda et al., 2021).

In addition to flavonoids, the compound andrographolide contained in it significantly reduces blood glucose levels, LDL, and triglycerides (Nugroho et al., 2013). Tannins function to enhance the metabolism of glucose and fat, preventing an excess of both calorie sources in the blood. Tannins also activate Mitogen Activated Protein Kinase (MAPK) and Phosphoinositide (PI3K), leading to increased glucose uptake into cells and a decrease in blood glucose levels (Iyos and Astuti, 2017). Alkaloids serve to regenerate damaged pancreatic beta cells. Alkaloids increase insulin secretion and reduce glucose absorption in the intestine, resulting in lowered blood sugar levels (Moghadamtousi et al., 2015).

In addition to serving as an antioxidant, flavonoid compounds like quercetin also enhance the performance of Glucose Transporter (GLUT) in transporting blood sugar into the cell membrane (Priyanto et al., 2021). GLUT is a transmembrane protein that assists cells in absorbing blood sugar through the process of diffusion. In mammals, there are 14 GLUTs, and four of them are better known, namely GLUT 1-4 (Watson and Pessin, 2001). The performance of GLUT is influenced by several factors, such as insulin sensitivity. According to Utama (2014), GLUT 1-3 are not affected by insulin, unlike GLUT 4.

According to Wood and Trayhurn (2003), GLUT 4 is located in muscles, the brain, heart, and adipose tissue, and it has a higher affinity compared to GLUT 1-3. GLUT 4 is the transporter responsible for insulin's effect on reducing postprandial (after meals) blood sugar levels (Huang and Ceko, 2007). This indicates that if GLUT, especially GLUT 4, is not sensitive to insulin, GLUT 4 will not function, preventing cells from absorbing glucose from the blood.

According to Priyanto et al. (2021), secondary metabolites can enhance the expression of GLUT 4 in response to insulin, making GLUT 4 more sensitive to insulin. Bryant et al. (2002) reported that the primary function of insulin is to stimulate the transport of glucose into cells, especially muscle and adipose cells, which is then used as an energy source. Secondary metabolites such as quercetin and kaempferol have been studied and found to increase the activation of the AMPK-P38 pathway, which plays a role in regulating insulin sensitivity and glucose metabolism. This helps in the absorption of glucose into the cell membrane and improves oxidative stress markers in adipose tissue, such as Nrf2 (Anggaraini, 2020).

Table 1. Medicinal Plant Diversity for Diabetes in Sanggabuana, Karawang, West Java

No.	Scientific Name	Local Name	Tribe	Usage Section	How to use	Single Technique Mixed	FL	UV
1	*Achillea millefolium L.*	Thousand Leaves	*Asteraceae*	Leaves	The leaves are boiled as much as 5-7 sheets then drunk	Single	2.63	2.63
2	*Areca catechu*	Betel Nut	*Arecaceae*	Roots	The root with 7 other roots is boiled to taste and then drunk	Mixed, one of 7 roots	2.63	2.63
3	*Centella asiatica*	Gotu Kola	*Apiaceae*	Leaves	The leaves are boiled as much as 5-7 sheets then drunk	Single	2.63	2.63
4	*Chromolaena odorata*	Siam Weed	*Asteraceae*	Leaves	Leaves are boiled 5-7 sheets, then filter and drink	Single	5.26	2.63
5	*Cocos nucifera L.*	Coconut	*Palmae*	Roots	The root with 7 other roots is boiled to taste and then drunk	Mixed, one of 7 roots	2.63	2.63
6	*Cordyline fruticose*	Ti Plant	*Asparagaceae*	Leaves	The leaves are boiled as much as 5-7 sheets then drunk	Single	2.63	2.63
7	*Crescentia cujete*	Calabash	*Bignoniaceae*	Leaves	The leaves are boiled as much as 5-7 sheets then drunk	Single	2.63	2.63
8	*Dendrocnide stimulans*	Cowitch	*Urticaceae*	Trunk	Sliced and left overnight, the water is taken and drunk.	Single	2.63	2.63
9	*Graptophyllum pictum*	Caricature Plant	*Acanthaceae*	Leaves	The leaves are boiled as much as 5-7 sheets then drunk	Single	2.63	2.63
10	*Gynura procumbens*	Longevity Spinach	*Asteraceae*	Leaves	The leaves are boiled as much as 5-7 sheets then drunk	Single	2.63	2.63

11	*Hemigraphis colorata*	Red Ivy	*Acanthaceae*	Leaves	The leaves are boiled as much as 5-7 sheets then drunk	Single	5.26	2.63
12	*Imperata cylindrica*	Cogon Grass	*Poaceae*	Roots	Boiled to taste, then drunk	Mixed, one of 7 roots	2.63	2.63
13	*Melia azedarach*	Chinaberry	*Meliaceae*	Leaves	The leaves are boiled as much as 5-7 sheets then drunk	Single	2.63	2.63
14	*Mimosa pudica*	Sensitive Plant	*Fabaceae*	All parts	Boiled to taste, then drunk	Mixed, one of 7 roots	2.63	2.63
15	*Moringa oleifera*	Moringa	*Moringaceae*	Leaves	Leaves are boiled to taste, then drunk	Single	10.53	2.63
16	*Muntingia calabura*	Jamaican Cherry	*Muntingiaceae*	Leaves	The leaves are boiled as much as 5-7 sheets then drunk	Single	2.63	2.63
17	*Orthosiphon aristatus*	Cat's Whiskers	*Lamiaceae*	Leaves	The leaves are boiled as much as 5-7 sheets then drunk	Single	2.63	2.63
18	*Physalis angulata L.*	Ciplukan	*Solanaceae*	Leaves	Leaves are dried 7-9 pieces, then boiled and drunk	Single	2.63	5.26
				Roots	The root with 7 other roots is boiled to taste and then drunk	Mixed, one of 7 roots	2.63	
19	*Ruellia tuberosa L.*	Wild Petunia	*Acanthaceae*	Leaves	The leaves are boiled as much as 5-7 sheets then drunk	Single	2.63	2.63
20	*Sandoricun koetjape*	Kecapi	*Meliaceae*	Leaves	The shoots are boiled as many as 5-7 sheets and then drunk	Single	2.63	2.63
21	*Staurogyne elongata*	Star Grass	*Acanthaceae*	Roots	The root with 7 other roots is boiled to taste and then drunk	Mixed, one of 7 roots	2.63	2.63

22	*Smallanthus sonchifolius*	Yacon	*Asteraceae*	Leaves	The leaves are boiled as much as 5-7 sheets then drunk	Single	5.26	2.63
23	*Solanum torvum*	Turkey Berry	*Solanaceae*	Leaves Roots	The leaves are boiled as much as 5-7 sheets then drunk The root with 7 other roots is boiled to taste and then drunk	Single Mixed, one of 7 roots	5.26 2.63	5.26
24	*Strobilanthes crispus*	Java Tea	*Acanthaceae*	Leaves	The leaves are boiled as much as 5-7 sheets then drunk	Single	2.63	2.63
25	*Syzygium polyanthum*	Indonesian Bay Leaf	*Myrtaceae*	Leaves	The leaves are boiled as much as 5-7 sheets then drunk	Single	7.89	2.63
26	*Zingiber cassumunar*	Cassumunar Ginger	*Zingiberaceae*	Rhizome	The rhizome is grated and then boiled, then drunk twice a day.	Single	2.63	2.63

Medicinal Plants for Diabetes Mellitus.

Based on the interview results with respondents, the medicinal plants for Diabetes Mellitus utilized by the community in the Sanggabuana Village area consist of 26 plant species belonging to 17 families. These medicinal plants are utilized as traditional remedies, serving as alternatives and initial steps for treatment and care. They can be directly sourced from home gardens, community cultivation areas, or from the forest. The medicinal plants used come from various plant families, as depicted in Figure 2.

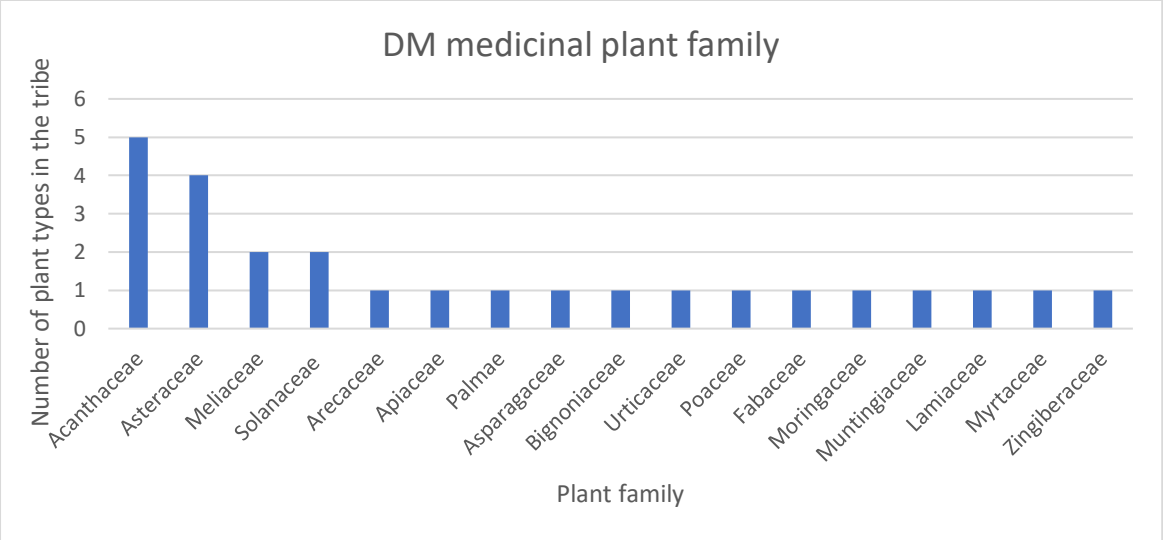

Figure 2. Diagram of Medicinal Plant Families for Diabetes mellitus

In Sanggabuana, 26 species of medicinal plants for Diabetes Mellitus were found, belonging to 17 families, including Acanthaceae (5 species), Asteraceae (4 species), Meliaceae (2 species), Solanaceae (2 species), and plant families with only 1 species each, such as Arecaceae, Apiaceae, Palmae, Asparagaceae, Bignoniaceae, Urticaceae, Poaceae, Fabaceae, Moringaceae, Muntingiaceae, Lamiaceae, Myrtaceae, and Zingiberaceae.

The Acanthaceae family is the most widely utilized medicinal plant by the Sanggabuana community for treating diabetes mellitus (DM). The Acanthaceae family exhibits various pharmacological activities, including antioxidant, anti-inflammatory, antidiabetic, analgesic, photoprotective, immunomodulatory, nephroprotective, antihemorrhoid, and antibacterial effects (Santi and Raden, 2021). The reduction in blood glucose levels can occur due to the presence of flavonoid compounds, which can promote the regeneration of β-pancreatic cells and aid in increasing insulin secretion. Additionally, flavonoids can reduce glucose absorption and control the activity of enzymes involved in glucose metabolism. In addition to flavonoids, alkaloids also play a role in regenerating damaged β-pancreatic cells. Alkaloids work through extra-pancreatic mechanisms, where they can increase glucose transport in the blood, inhibit glucose absorption in the intestines, inhibit glucose synthesis, and stimulate glycogen synthesis (Rosmiati and Fernando, 2017). The Acanthaceae family also exhibits hypoglycemic effects in mice, making it effective for use as an antidiabetic agent. Acanthaceae contains various chemical substances, including potassium, sodium, calcium, alkaloids, saponins, flavonoids, and polyphenols. These chemical constituents work synergistically to inhibit the activity of α-

glucosidase enzymes. Inhibiting α-glucosidase enzymes subsequently hinders the breakdown of carbohydrates into glucose, leading to a decrease in blood glucose levels (Samal, 2013).

Plants of the Asteraceae family contain various secondary metabolites such as flavonoids, phenols, tannins, steroids, and saponins. The Asteraceae family possesses essential oils with contents including limonene, α-pinene, β-caryophyllene, cadinene, cadinol isomer, and camphor (Inya-agha et al., 1987). Plants of the Asteraceae family exhibit antioxidant properties, capable of neutralizing free radicals that contribute to the onset of various degenerative diseases. The antioxidant properties in Asteraceae plants are attributed to the chemical compounds present in their leaves, especially flavones, flavonols, flavanones, chalcones, and hydroxy benzoic acid (Alisi et al., 2011). Besides flavonoids (aurone, chalcone, flavone, and flavonol), other substances with antioxidant roles include alkaloids, tannins, saponins, and other phenolic compounds (Yuliani, 2012). The mechanism of flavonoids as antidiabetic agents involves preventing damage and repairing β-pancreatic cells, reducing lipid peroxidation by slowing the onset of necrosis in cells, and enhancing vascularization to prevent cell damage and promote cell regeneration (Barku et al., 2013).

In the Meliaceae family, plants are used as alternative medicine for diabetes mellitus by being dried and then brewed, as demonstrated by Chaturvedi et al. (2007) in a study on the effects of methanol extract from chinaberry fruit (Melia azedarach L.), indicating anti-diabetic activity. Its main compounds include Phytol, Quercetin, and palmitic acid (Sen et al., 2012).

In the Solanaceae family, various secondary metabolites are present, including flavonoids, alkaloids, steroids/triterpenoids, tannins/polyphenols, saponins, anthraquinones, anthracenes, and terpenoids (Petersmann et al., 2018). The Solanaceae family contains flavonoids that function as antioxidants to protect pancreatic beta cells from the toxic effects of free radicals produced during hyperglycemia (Wulandari et al., 2020).

The Acanthaceae family is more widely utilized because in the Sanggabuana region, the Acanthaceae family is more easily found, there is greater trust among the residents in the Acanthaceae family, and many Acanthaceae plants are grown in residents' home gardens. Therefore, the Acanthaceae family is more extensively utilized compared to the Asteraceae, Meliaceae, and Solanaceae families.

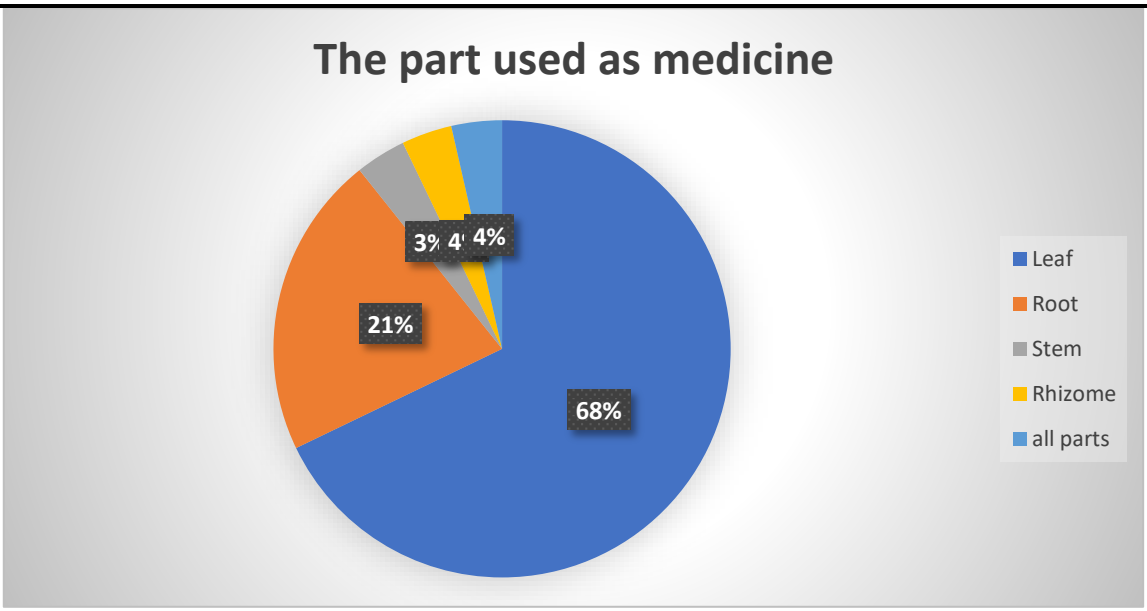

Figure 3. Diagram of Plant Parts Used as Medicine

Based on Figure 3, the plant parts used for diabetes mellitus treatment include leaves from 19 plant species (68%), including *Achillea millefolium* L, *Centella asiatica*, *Chromolaena odorata, Cordyline fruticosa, Crescentia cujete, Graptophyllum pictum, Gynura procumbens*, *Hemigraphis colorata*, *Melia azedarach*, *Moringa oleifera*, *Muntingia calabura*, *Orthosiphon aristatus*, *Physalis angulata* L, Reullia tuberosa L, *Sandoricun koetjape*, *Smallanthus sonchifolius*, *Solanum torvum*, *Strobilanthes crispus*, and *Syzygium polyanthum*. Roots from 6 plant species (21%), including *Areca catechu*, *Cocos nucifera* L, *Imperata cylindrica*, *Physalis angulata L, Staurogyne elongata,* and *Solanum torvum*. Stems from 1 plant species (4%), namely *Dendrocnide stimulans*. Rhizomes from 1 plant species (4%), namely *Zingiber cassumunar*. And all parts from 1 plant species (3%), namely *Mimosa pudica*.

The plant part most frequently used by the residents of Sanggabuana Village is the leaves. This is because leaves contain many compounds such as tannins and alkaloids that are beneficial for medicinal purposes (Larasati et al., 2019). Handayani (2003) stated that leaves are commonly used in traditional medicine because they generally have a soft texture, high water content (70-80%), and serve as an accumulation site for photosynthates believed to contain elements (organic substances) with healing properties. Additionally, leaves are abundant in nature, easily found, and their collection and processing are considered very simple and straightforward (Hara, 2009). Furthermore, leaves are the primary photosynthetic organs of plants and are considered a key component in the synthesis of bioactive compounds in plants, serving as active ingredients that can be used for medicinal purposes (Adiyasa and Meiyanti, 2021).

Processing Methods of Medicinal Plants

The results of interviews with respondents regarding the utilization methods of medicinal plants used by residents in the Sanggabuana area, Karawang, West Java, can be seen in Figure 4. Two utilization methods were identified, namely boiling (26) and consumption without processing/direct consumption (1).

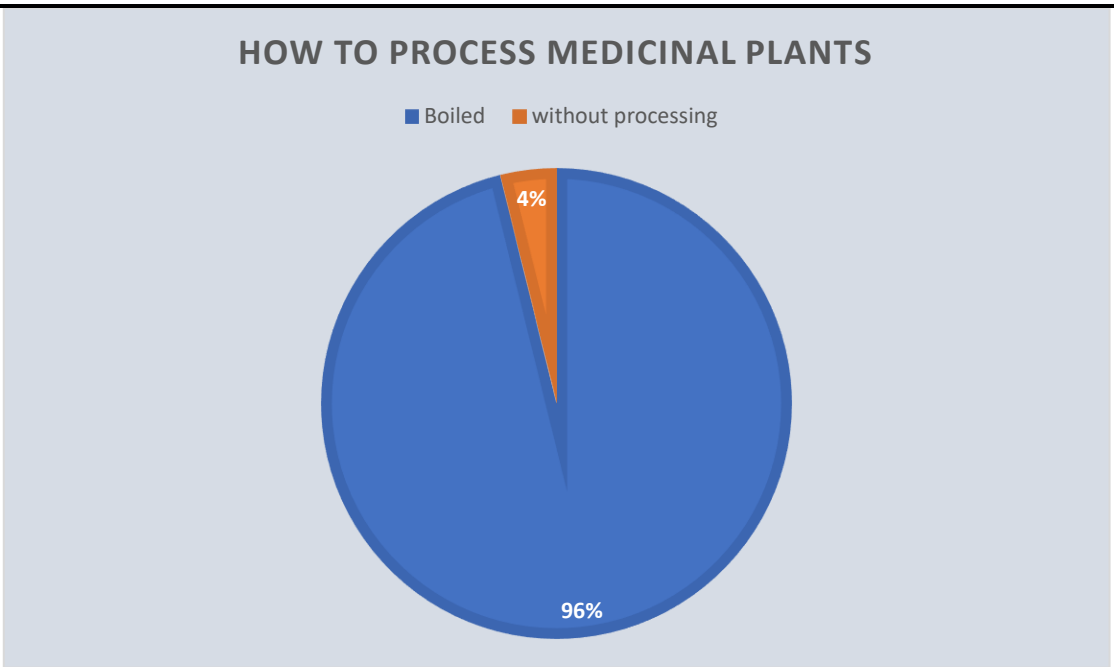

Figure 4. Processing Methods of Medicinal Plants

The most commonly used processing method by residents in the Sanggabuana area, Karawang, West Java, is boiling. Boiling is the most frequently practiced method of processing by the community. The purpose of boiling is to dissolve the beneficial substances present in the plants into the water solution, which is then consumed for medicinal purposes (Leisha, 2017). Essentially, the use of medicinal plants by the community is simple, derived solely from the experience and information passed down from previous generations. The treatment practices also lack knowledge of the exact dosage, but the most important aspect is processing the plants so that they can be used for treatment (Anggana, 2011). According to Djojosugito (1985), in traditional communities, traditional medicine is divided into two categories: traditional remedies or formulations and the methods of processing medicinal plants. Traditional remedies are those passed down through generations and used by the community to treat specific diseases; they can be freely obtained from nature.

According to Botanical (2011), boiling is done so that the medicinal compounds in the leaves can dissolve into the boiled water. Hardadi (2005) argues that boiling is an effective, economical, and efficient method because repeated boiling will not affect the efficacy of the medicine. Boiling can be applied to leaves, flowers, rhizomes, or plant stems (Fariz et al., 2018). According to Mahendra (2006), the purpose of boiling medicinal plants is to transfer the beneficial substances into the water for consumption according to the treatment. Processing medicinal plants by boiling can reduce the bitterness compared to consuming them directly and is also more sterile, as it can kill germs or pathogenic bacteria during the boiling process (Saudah et al., 2018).

Use Value (UV) and Fidelity Level (FL)

Based on the calculation of Use Value (UV), the highest values were obtained for the Ciplukan plant (*Physalis angulata* L.) and Tekokak (*Solanum torvum*) with a UV value of 5.26%. Meanwhile, for the highest Fidelity Level (FL), it is the Moringa (*Moringa oleifera*)

plant with an FL value of 10.53%. Ayyanar and Ignacimuthu (2011) stated that the higher the UV value, the more useful the plant is compared to other plants. According to Khan et al. (2014), plants with the highest FL tend to be recognized and trusted within the community for treating a specific disease.

Ciplukan (*Physalis angulata* L.) is a plant with a high Use Value (UV) that contains flavonoids, alkaloids, steroids/triterpenoids, tannins/polyphenols, saponins, anthraquinones, anthracenes, and terpenoids (Petersmann et al., 2018). Ciplukan contains flavonoids that function as antioxidants to protect pancreatic beta cells from the toxic effects of free radicals produced during hyperglycemia. The avoidance of toxic effects on pancreatic beta cells helps maintain insulin levels, ensuring normal blood glucose levels. Additionally, flavonoids in ciplukan can inhibit the enzyme α-glucosidase (Wulandari et al., 2020). The antioxidant activity in ciplukan is associated with its anti-diabetic properties, as antioxidants can reduce oxidative stress to prevent the onset of diabetes mellitus and avoid complications in patients (Middleton et al., 2000).

Moringa (*Moringa oleifera* Lam.) is a plant used by communities in traditional medicine. The phytochemical compounds in moringa leaves include tannins, steroids, terpenoids, flavonoids, saponins, anthraquinones, alkaloids, proteins, vitamins, beta-carotene, amino acids, and various phenolic compounds (Kasolo et al., 2010). The flavonoid content in moringa leaves functions as an antidiabetic and anti-inflammatory agent (Bhattacharya et al., 2018). Triterpenoid compounds are also found in moringa leaves (Moringa oleifera). Triterpenoids in moringa leaves are believed to stimulate insulin secretion from pancreatic beta cells into the bloodstream (Ambarwati et al., 2014).

CONCLUSION

From the interview results, 26 types of plants can be used as herbal medicine for diabetes mellitus (DM). The plant part most commonly used for DM treatment is the leaves. The most frequently used processing method by the Sanggabuana community is boiling. The plants with the highest Use Value (UV), indicating their extensive utility, are Tekokak (*Solanum torvum)* and Ciplukan (*Physalis angulata*) , both at 5.26%. The plant with the highest Fidelity Level (FL) for treating Diabetes Mellitus is *Moringa oleifera* (kelor) with a value of 10.53%. However, in terms of community trust for treating Diabetes Mellitus among the 26 plant types, Moringa is the most trusted. Based on the interview results, the most commonly used part of the plant is the leaves (19 types out of 26), and the most common processing method is boiling (25 types), with 2 other plants consumed without processing.

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