

Phytochemicals of Common Medicinal Plants Utilized for Diabetes in Selected Municipalities in Sultan Kudarat Province, Philippines

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ABSTRACT

The study identified medicinal plants and their phytochemical constituents used by 100 patients with diabetes in Sultan Kudarat province from July 2018 to December 2019. Through collaboration with Municipal Health Offices and Barangay Local Government Units, purposive and snowball sampling facilitated location and interviews using a researcher-designed questionnaire. Respondents mentioned 28 medicinal plants as adjuncts to their prescribed antidiabetic medications. The most commonly used were *Annona muricata* (guyabano), *Hibiscus esculentus* (L) Moench (Lady's finger/okra), *Momordica charantia* L. (Bitter melon/gourd); *Costus igneus* N.E.Br. (insulin plant), *Garcinia mangostana* L. (mangosteen), *Lagenaria siceraria* (miracle fruit/calabash), *Curcuma longa*, L. (turmeric), *Phyllanthus niruri*, L. (Chanca Piedra/stonebreaker), *Moringa oleifera* Lam. (drumstick tree/horseradish tree), and *Gynura procumbens* (Lour.) Merr. (green tea). Laboratory-based phytochemical screening is recommended to verify reported bioactive compounds, as prior studies have documented antidiabetic flavonoids and alkaloids in these species, highlighting their potential as complementary therapies to control diabetes complications.

Keywords: Bioactive remedies, diabetic patients, herbal plants, phytochemicals, therapy

INTRODUCTION

Herbs have been used to treat diseases almost universally in non-industrialized societies because they are more affordable than many modern pharmaceutical products. The World Health Organization (WHO) estimates that 80% of the population of some Asian and African countries currently uses herbal medicine for some aspect of primary health care. In the United States and Europe, herbal medicine is less commonly used in clinical settings, but its use has increased in recent years as more scientific evidence on its effectiveness has become available. In 2011, the annual global export value of pharmaceutical plants reached over US \$2.2 billion (Lichterman et al.; 2014).

The Philippines has many endemic plants, herbs, and trees that are used as herbal medicine (Stuart (2013) at <http://www.stuartxchange.org>). Medicinal plants are a rich source of pharmacologic active compounds, and researchers are increasingly focusing on phytochemicals for the treatment of various human ailments. Survey results indicate that medicinal plants are used by diabetic patients, which creates an opportunity for further research, specifically on the phytochemical components of commonly used plants to validate existing claims and information. The findings may serve as a reference for local communities and provide a stronger basis for medical intervention and future medicinal or pharmaceutical product development.

Diabetes mellitus is one of the major causes of morbidity and mortality worldwide. It is a syndrome characterized by hyperglycemia, polydipsia, and polyuria and causes complications to the eyes, kidneys, and nerves. It is also associated with an increased risk of cardiovascular disease. The worldwide incidence is estimated to rise from 151 million in the year 2000 to 221 million by the year 2010 and to 300 million by 2025 (Pushparaj, 2004). In the Philippines, diabetes is becoming a major public health issue. as mentioned by

Higuchi (2009), the WHO projected that the number of diabetic patients would reach 7.8 million in 2030, up from 2.8 million in 2000, while PhilHealth paid out 265 million pesos for diabetes-related admissions in 2006.

According to Vats et al., 2002, as cited by Qureshi, Asad, and Sultan (2009), the commonly practiced treatments for diabetes include oral anti-diabetic drugs, insulin injections in severe cases, and management through diet and physical exercise. However, in the Philippines, adherence to oral medications, for instance, is often affected by financial problems. Higuchi (2009) reported that the country has some of the highest medicine prices in Asia despite policy interventions such as the 'Generics Act of 1988', and the 'Pharma 50 project'. Since there is an evident economic burden of life-long treatment process, many patients turn to alternative medicine including dietary supplements, megadose vitamins, and herbal preparations as adjunct therapy for diabetes. Few medicinal plants that have been scientifically studied for their anti-diabetic properties, yet their use is becoming more widespread. This study will provide information on the medicinal plants and their chemical components available in Sultan Kudarat province for the partial management of diabetes. As cited by Suharjito (2014) scientific research on local medicinal plants may strengthen the role of local communities in traditional medicine, improve the economy, and enhance access to healthcare.

Objectives

This study was conducted to determine the medicinal plants utilized by diabetic patients in the four selected municipalities of Sultan Kudarat Province, Mindanao, Philippines, and to assess the phytochemicals present in the commonly used medicinal plants for diabetes based on published materials. The results will serve as basis for primary laboratory analysis and validation which are necessary prerequisites for preclinical studies and product development.

Framework Of the Study

Plants have long been an important source of drugs. Ethnobotanical studies report that about 800 plant species may have anti-diabetic potential. The medicinal value of plants in traditional health systems has been widely documented across many cultures. In many cases, plants are used as dietary adjuncts or remedies for various diseases even when their active constituents and mechanisms are not yet fully understood. This practice may be linked to the high cost and side effects of synthetic hypoglycemic agents. Although many synthetic drugs have been developed for diabetes mellitus, a treatment that is both safe and fully effective remains elusive (<https://benthamopen.com/contents/pdf/TOPHARMCJ/TOPHARMCJ-5-11.pdf>)

This study is anchored on the idea of Pushparaj (2004) who emphasized that numerous biologically active plants have been identified ethnopharmacological evaluation. These plants may provide local communities with readily accessible therapeutic products. Likewise, Lakshmi, et al. (2012) noted that there is substantial evidence supporting the use of herbal plants in the treatment of diabetes mellitus. They identified several plant families with confirmed hypoglycemic activity, including *Leguminosae*, *Lamiaceae*, *Liliaceae*, *Asteraceae*, *Moraceae*, *Rosaceae*, *Euphorbiaceae*, *Araliaceae*, *Polygalaceae*, *Asclepiadaceae*, and *Meliaceae*. They further stated that clinical studies have confirmed the therapeutic importance of medicinal plants in diabetes management, particularly in delaying complications and rectify metabolic abnormalities.

Guided by these studies, the researchers conducted the survey on the medicinal plants used by selected communities in the management of diabetes. The results will provide the basis for laboratory phytochemical screening to determine and validate the medicinal potential of the identified plants. Ultimately, the findings will be used to guide recommendations on the continued use of these plants as supportive or alternative therapies for diabetes.

METHODOLOGY

The study was descriptive in nature and aimed to explore the use of alternative medicine among patients diagnosed with diabetes mellitus. A survey questionnaire was developed and pretested among five (5) diabetic patients to determine its clarity, appropriateness and ability to gather the data needed to meet objectives of the study.

A total of 100 respondents were identified through purposive and snowball sampling with the assistance and recommendations of the Municipal Health Office and Barangay LGUs in Sultan Kudarat Province. Only individuals who were medically diagnosed with diabetes and were known users of alternative medicines, specifically in the municipalities of Esperanza, Isulan, Lebak, and Kalamansig were included in the interview, provided they gave their consent and willingness to participate in the study.

The World Health Organization (WHO) has recommended the evaluation of traditional plant treatments for diabetes because they are considered effective, non-toxic, and associated with fewer or no side effects, making them promising candidates for oral therapy. Scientific validation of several plant species has shown their capacity to reduce blood sugar levels. Based on reports of their potential antidiabetic effects, phytochemicals are believed to play a major role in diabetes management, which needs further investigation for the development of drugs and nutraceuticals from natural resources.

The medicinal plant use reported by the respondents was analyzed using descriptive statistics specifically frequency and percentages. The phytochemicals commonly found in the medicinal plants were identified through a manual review of relevant references available in Google Scholar, Science Direct, and other databases with phytochemical activity data.

After identifying medicinal plants with potential antidiabetic properties from published sources, the next step will be laboratory processing and analysis of their bioactive compounds to confirm the presence of phytochemicals in the selected plants. The identified phytochemicals may then serve as a basis for product development, particularly in identifying beneficial plant parts that can be used to create products for diabetics.

RESULTS AND DISCUSSION

Commonly Used Antidiabetic Medicinal Plants

As shown in Table 1, twenty-eight (28) medicinal plants were identified by the respondents as having potential use in the management of diabetes. Based on the responses of 100 diabetic patients, the most commonly used plants were *Annona muricata* (guyabano), used by 22% of respondents, *Hibiscus esculentus* L. (Lady's finger/okra) and *Momordica charantia* L. (bitter melon/gourd), each used by 21%, and *Costus igneus* N.E.Br. (insulin plant), used by 19%. Other frequently used plants included, *Garcinia mangostana* L. (mangosteen) at 9%, *Lagenaria siceraria* (miracle fruit/calabash) at 7%, *Curcuma longa* L. (turmeric) at 6% and *Phyllanthus niruri*, L. (Chanca Piedra/stonebreaker), *Moringa oleifera* Lam. (drumstick/horseradish tree), and *Gynura procumbens* (Lour.) Merr. (green tea), each at 5%.

Other medicinal plants utilized by the respondents were *Orthosiphon aristatus* (cat's whiskers/Java tea), *Cnidioscolus aconitifolius* (Chaya leaves; tree spinach), *Archangelisia flava* (Albutra), *Cymbopogon citratus* (lemon grass), *Chorchorus olitorius* (Jute mallow/jute leaves/Egyptian spinach), *Catharantus roseus* (Madagascar/rosy periwinkle), *Antidesma bunius* (Chinese laurel/salamander/currant tree/wild cherry), *Tinuspora rumphii* (heavenly elixer/bitter grape/heartleaf moonseed), *Coriandrum sativum* (Coriander/cilantro), *Tabebuia avellanedae* (pau d'arco/pink trumpet tree/taheebo), *Andrographis paniculata* (King of Bitters/Creat/Green Chireta/Indian echinacea), *Caesalpinia sappan* (Sappan/Indian red wood/Brazilwood tree), *Zea mays* (corn silk), *Artocarpus heterophyllus* (jackfruit leaves), *Hylocereus undatus* (dragon fruit), *Cucumis sativus* L.(cucumber), *Daucus carota* (carrot), and *Bixa orellana* (Annatto/lipstick tree).

The medicinal plants are known to have at least one of these characteristics antidiuretic, anti-inflammatory, antianalgesic, anticancer, anti-viral, anti-malarial, anti-bacterial and anti-fungal activities as they contain either one of the secondary metabolites such as at least one of alkaloids, flavonoids, terpenoids, reducing sugars and phlobotannins (Table 2).

Hibiscus esculentus L., commonly known as lady's finger or okra belongs to the mallow family, a group of flowering plants. It is widely cultivated in tropical and warm regions of the world, although this species remains poorly studied (Amin, 2011). It has gained its own popularity as a plant used for the management of

diabetes (Diabetes.co.uk, 2016). Studies have shown that viscous soluble dietary fiber can significantly reduce intestinal glucose absorption in fasting rats (Khatun et al, 2011), while the peel and seeds may help normalize blood glucose and improve lipid profiles in diabetic conditions (Sabithat et al, 2011).

Costus igneus N.E.Br. , commonly known as the insulin plant, is a perennial species in the family Costaceae that grows upright and reaches about two feet in height. Its leaves are spirally arranged and has attractive flowers (Pegde, 2014). Consumption of the leaves is believed to lower blood glucose levels, and some diabetics who consumed the leaves of this plant did report a fall in their blood glucose levels (Shette, 2011). It is used in India to control diabetes, and it is known that diabetic people eat one leaf daily to keep their blood glucose low (Urooj, 2008). In a study conducted by Shety et al (2011), the leaves of *Costus igneus* reduced the fasting and postprandial blood sugar levels, bringing them towards normal, in dexamethasone-induced hyperglycemia in rats.

Momordica charantia (bitter melon/gourd) is a monoecious, annual vine having a five-ridged stem and simple tendrils. The leaves are simple, pellucidly dotted, palmately veined; petiole is 1 -7 cm long; leaf-blade broadly ovate-reniform or suborbicular in outline leaves obovate and sinuate-lobulate or sinuate-toothed. The flowers are axillary, solitary, about 3 cm in diameter, and yellow. The fruits are 3-11 cm x 2-4 cm, irregularly warty, orange dehiscent from apex downwards to the base into three valves. The seeds are 8-16 mm x 4-10 cm x 2.5-3.5 mm, and brown in color (DA Region 10, 2013).

In the Philippines, bitter melon (ampalaya) is one of herbal medicine for management of Diabetes mellitus that was endorsed by the Department of Health. Research showed that the main components of ampalaya which are responsible for the antidiabetic effects are triterpene, proteid, steroid, alkaloid, inorganic, lipid, and phenolic compounds (Saeed et al, 2009). Since the beneficial function of *M. charantia* is supported by modern scientific evidence, it is one of the most promising plants for diabetes (Joseph and Jini, 2013).

As cited by Lana, et al (2020), *Lagenaria siceraria* (miracle fruit/calabash) is another commonly consumed plant especially for its aerial parts and fruits, which are eaten as vegetables and contain carbohydrates, proteins, minerals and vitamins. Because of its nutritional value, it can support general health maintenance, despite there is still a need for determining its antidiabetic potential.

The phytochemical analysis of *Gynura procumbens* (green tea) revealed that it has chlorophyll-a, b, alkaloids, volatile oils and carotenoids in ethanolic contents. This result indicates a good natural source of bioactive compounds and that they may have beneficial health effects when consumed. On the other hand, *Garcinia mangostana* L. (mangosteen) fruit pulp has high phytochemical contents such as polyphenols (phenolic acids, anthocyanin, proanthocyanin, and xanthone) and cyanidin-3-sophoroside and cyanidin-3-glucoside. The rind portion has antimicrobial, antioxidant, and antitumoral activities (Bhat and Paliyath, 2016).

It is also observed in Table 1 that, some respondents utilized more than one of the medicinal plants. Traditional medicine involves the use of different plant extracts or the bioactive constituents. Through a qualitative phytochemical analysis of these plants the presence of various phytochemicals like alkaloids, flavonoids, tannins, saponins, and proteins, gums, and mucilage, phytosterols can be confirmed, thus having such information is useful to the isolation of new and novel compounds for curing various ailments, not only diabetes.

Table 1. Percentage utilization of common medicinal plants utilized for diabetes in selected municipalities in Sultan Kudarat Province, Mindanao, Philippines.

Medicinal Plant Nomenclature		Frequency n=100	Percentage
Scientific Name	Common Name/s		
1. <i>Annona muricata</i>	Guyabano	22	22%
2. <i>Hibiscus esculentus</i> L.	Okra/Lady's finger	21	21%
3. <i>Momordica charantia</i> L.	Bitter melon/bitter gourd)	21	21%
4. <i>Costus igneus</i> N.E.Br.	Insulin plant	19	19%

5. <i>Garcinia mangostana</i> L.	Mangosteen	9	9%
6. <i>Lagenaria siceraria</i>	Miracle fruit/calabash	7	7%
7. <i>Curcuma longa</i>	Turmeric	6	6%
8. <i>Phyllanthus niruri</i> , Linn.	Chanca Piedra/Stonebreaker	5	5%
9. <i>Moringa oleifera</i>	Drumstick/horseradish tree	5	5%
10. <i>Gynura procumbens</i>	Green tea; mollucan spinach	5	5%
11. <i>Orthosiphon aristatus</i>	Cat's whiskers/Java tea	3	3%
12. <i>Cnidioscolus aconitifolius</i>	Chaya leaves/tree spinach	3	3%
13. <i>Archangelisia flava</i>	Albutra	3	3%
14. <i>Cymbopogon citratus</i>	Lemon grass	2	2%
15. <i>Chorchorus olitorius</i>	Jute mallow/leaves/Egyptian spinach	2	2%
16. <i>Catharantus roseus</i>	Madagascar periwinkle/rosy periwinkle	2	2%
17. <i>Antidesma bunius</i>	Chinese laurel/salamander/currant tree/wild cherry	2	2%
18. <i>Tinuspora rumphii</i>	Heavenly elixer/bitter grape/heartleaf moonseed	2	2%
19. <i>Coriandrum sativum</i>	Coriander/cilantro	1	1%
20. <i>Tabebuia avellanadae</i>	pau d'arco/pink trumpet tree/taheebo	1	1%
21. <i>Andrographis paniculata</i>	King of Bitters/Creat/Green Chireta/Indian Echinacea	1	1%
22. <i>Caesalpinia sappan</i>	Sappan/Indian red wood/Brazilwood tree	1	1%
23. <i>Zea mays</i>	Corn silk	1	1%
24. <i>Artocarpus heterophyllus</i>	Jackfruit	1	1%
25. <i>Hylocereus undatus</i>	Dragon fruit	1	1%
26. <i>Cucumis sativus</i> L.	Cucumber	1	1%
27. <i>Daucus carota</i>	Carrot	1	1%
28. <i>Bixa orellana</i>	Annatto/Lipstick tree	1	1%

Phytochemical Profile of the Medicinal Plants

The website <https://www.sciencedirect.com/science/article/pii/S0965229918301249> mentioned that the use of plants with medicinal value are associated with several health benefits. In Brazil, for instance, the rich flora has long been used in traditional medicine, but there is a consensus about the lack of ethnopharmacological studies to identify the most used species. Many plants are employed without any preliminary evaluation to confirm their reported medicinal uses.

Medicinal plants are the main sources of organic compounds such as polyphenols, tannins, alkaloids, carbohydrates, terpenoids, steroids, and flavonoids. These organic compounds represent a source for the discovery and development of new types of antidiabetic molecules. Many compounds isolated from plant sources have been reported to show antidiabetic activity (<https://www.ncbi.nlm.nih.gov/pubmed/26417272>). This is also supported by Edeoga et al. (2005) as cited by Krishnalah, et al. (2009) who stated that some of the most important bioactive phytochemical constituents of medicinal plants are alkaloids, essential oils, flavonoids, tannins, terpenoids, saponins, phenolic compounds and many more.

Secondary metabolites are specific to plant species and have many applications such as medicines and food additives. Different alkaloids have been isolated from several medicinal plants and investigated for their possible antidiabetic activity in different animal models. Alkaloids exert a wide range of antidiabetic activities through different mechanisms. Some important classes of alkaloids reported with their mechanism of hypoglycemic or hyperglycemic activity.

As shown in Table 2, biochemical compounds were present in the 28 medicinal plants as identified from reviewed published reference materials. Plants are naturally rich in antioxidants which are often associated

with a reduction of health risks in diseases like diabetes. There are four medicinal plants containing almost all of the phytochemicals such as saponins, sterols, phenolics, tannins, flavonoids, terpenoids, and alkaloids and these are the *Curcuma longa* (turmeric), *Coriandrum sativum* (coriander), *Moringa oleifera* (Drumstick tree/horseradish tree) and *Catharantus roseus* (Madagascar/rosy periwinkle). *Annona muricata* (guyabano), *Hibiscus esculentus* L. (lady’s fingers/okra), *Momordica chuchinensis* (Bitter melon/gourd), contain six of the phytochemicals.

By contrast, *Garcinia mangostana* (mangosteen), *Lagenaria siceraria* (miracle fruit/calabash), *Antidesma bunius* (Chinese laurel/salamander tree/wild cherry), *Artocarpus heterophyllus* (jackfruit), *Hylocereus undatus* (dragon fruit), *Cucumis sativus* L. (cucumber), and *Orthosiphon aristatus* (cat’s whiskers/Java tea) possess little of the enumerated phytochemicals.

Lagenaria siceraria (miracle fruit/calabash) has also been reported as an antidiabetic remedy in Kurdistan region. The extract phytochemical study showed phenols, protocatechuic acid and luteolin-7-glucoside which are potent in lowering blood sugar as studied in mice (Juee and Naqishbandi, 2020).

Flavonoid is present in all the plants identified by the respondents. Tremendous studies have found that flavonoids originating from foods could improve glucose metabolism, and lipid profile, regulating the hormones and enzymes in the human body, further protecting human beings from diseases like obesity, diabetes, and their complications (<https://nutritionandmetabolism.biomedcentral.com/articles/10.1186/s12986-015-0057-7>)

Previous studies also support the study results. Bhaigyabati (2011) reported that corn silk contain flavonoids, alkaloids, phenols, steroids, glycosides, carbohydrates, terpenoids, and tannins.

Phytochemicals were extracted most effectively in methanol. Ojwang et al. (2017) found significant variation in the phytochemical composition of jackfruit roots, leaves, and bark, with roots showing the highest phenolic, flavonoid and tannin contents.

The respondents mostly used plant leaves (15 of the 28 medicinal plants) as tea, followed by consuming fruit parts of the six plants. Other plant parts used included flowers, wood bark and silk, mainly as component of their drinks. These findings indicate that different plant parts may vary in phytochemical composition and antioxidant potential. Thus, recommendations regarding the extraction and use of these bioactive compounds should be made with caution and supported by further laboratory validation and clinical trials to ensure safety and avoid possible adverse effects, especially among patients with diabetes.

Table 2. Phytochemical analysis of medicinal plant parts used by the respondents, and their antidiabetic potential based on published researches.

Medicinal Plant	Parts used	Phytochemical Contents							
		Alka- loid	Flavo- noid	Sapo- nin	Terpe- noid	Tan- nin	Phe-nols	Glyco- sides	Ste-roids
1. <i>Andrographis paniculata</i> (King of Bitters/Creat/ Green Chireta/ Indian Echinacea)	Leaves	+	+			+		+	
2. <i>Annona muricata</i> (Guyabano)	Leaves	+	+		+	+	+	+	
3. <i>Antidesma bunius</i> (Chinese laurel/ salamander tree/wild cherry)	Fruit		+						
4. <i>Archangelisia</i>	Leaves	+	+		+	+			

	<i>flava</i> (Albutra)								
5.	Artocarpus heterophyllus (Jackfruit)	Leaves		+			+		
6.	Bixa orellana (Annatto/Lipstick tree)	leaves	+	+		+	+	+	+
7.	Caesalpinia sappan (Sappan Indian red wood/Brazilwood tree)	Wood/Bark	+	+	+		+		+
8.	Catharantus roseus (Madagascar/rosey periwinkle)	Flower	+	+	+		+	+	+
9.	Chorchorus olitorius (Jute mallow/jute leaves/Egyptian spinach)	Leaves	+	+	+		+		+
10.	Cnidocolus aconitifolius (Chaya)	Leaves	+	+		+	+		+
11.	Coriandrum sativum (Coriander)	Leaves	+	+	+	+		+	+
12.	Costus igneus (Insulin plant)	Leaves	+	+	+	+	+		
13.	Crescentia cujete, L. (Miracle fruit/calabash)	Fruit		+				+	
14.	Cucumis sativus L. (Cucumber)	Fruit		+		+			
15.	Curcuma longa (Turmeric)	Rhizome	+	+	+	+	+		+
16.	Cymbopogon citratus	Leaves	+	+			+		+
17.	(Lemon grass)								
18.	Daucus carota (Carrot)		+	+	+	+	+		
19.	Garcinia mangostana (Mangosteen)	Fruit pulp		+				+	
20.	Gynura procumbens	Leaves	+		+				+
21.	(Green tea)								
22.	Hibiscus esculentus L. (lady's finger/Okra)	Fruit	+	+		+	+		+
23.	Hylocereus undatus (Dragon fruit)	Fruit		+			+		
24.	Momordica charantia (Bitter melon/gourd)	Leaves	+	+		+	+	+	+
25.	Moringa oleifera	Leaves	+	+	+		+	+	+

(Drumstick/ horse radish tree)									
26. Orthosiphon aristatus (Cat's whiskers/ Java tea)	Leaves		+			+			
27. Phyllanthus niruri, L. (Chanca Piedra/ Stonebreaker)	Leaves	+	+	+		+	+		
28. Tabebuia avellanedae (pau d'arco/pink trumpet tree/taheebo)	Bark		+				+		
29. Tinospora rumphii (Heavenly elixer/bitter grape/heartleaf moonseed)	Leaves	+	+					+	+
30. Zea mays (corn)	Silk	+	+		+	+			

Legend: + indicates the presence of bioactive compound.

CONCLUSION

Based on the findings of the study, medicinal plants are an important adjunct treatment practice among diabetic patients. Flavonoids which is known to possess properties for lowering blood glucose is found in all plants used by the respondents. Further, most of the plants contained an alkaloid, also of anti-diabetic potential. These findings suggest that the medicinal plants reported were promising materials for product development for diabetes management, provided that phytochemical screening and further validation are conducted.

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