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Alternative Medical Treatment for Diabetes: Beyond Allopathic Medicine.

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Abstract

Alternative Medical Treatment have been used as a source of medicine for thousands of years. Among the chronic diseases that cause high blood sugar levels and metabolic disorders is diabetes, which results in low insulin levels and high blood sugar levels. The increasing prevalence of diabetes, its complications, the growing use of complementary therapies, especially herbal remedies, and the need for countries to use indigenous medical methods led us to consider alternative therapies using herbs for let's treat diabetes.This review paper aims to identify and evaluate the importance and effectiveness of alternative medical treatments (AMT) for diabetes.This study firstly, discuss AMT trends around the world, then present a different type of diabetes , medicals herbs integration and challenges for developing AMT around the world. Moreover, it discusses the common traditional method of controlling diabetes using herbs and other methods. It was found that AMT by using medicinal plants are a priority in terms of being cheap, and their accessibility is much less than chemical drugs. However, that there are barriers in developing AMT throughout the world, such as lack of scientific investigation, political barriers, side effects, and socioeconomic barriers. The present study demonstrated that although some traditional therapies have been tested and approved in modern scientific studies, more studies are required to prove the effectiveness and wellbeing of these drugs. Hence, a greater attention must be paid to different types of traditional medicine, complementary methods, and university education in order to expand the production of medicines and natural products as alternative treatment.

Keywords: *Diabetes Treatment; Herbal Remedies; Alternative Medical Treatment; Traditional Medicine.*

1. Introduction

Medical plant today plays an important part among people, especially in rursal areas or community with less accessibility to biomedical (Siddique et al., 2021). By 1985, 30 million people had this disease, reaching 230 million by 2008. According to recent 2019 data from the International Diabetes Federation, in 1980, there were 108 million adults living with diabetes worldwide, but now there are an estimated 430 million adults living with diabetes worldwide (Aday & Matsushita, 2021; Unnikrishnan & Misra, 2021). In the adult population, diabetes prevalence has almost doubled from 4.7 to 8.5% since 1980.

Globally, approximately 175 million diabetics are unaware of their disease, which is expected to increase to 578 million by 2030 (Jain, Joshi, & Mohanty, 2021).

Diabetes and complications contribute to major economic losses for people with diabetes and family members as well as for health care services and economic systems due to direct medical costs and loss of jobs and incomes (Crocker, Palmer, Marrero, & Tan, 2021). Among alternative medical treatments (AMT), herbal medicines have grown rapidly because of their natural origins and fewer side effects in recent years. The majority of traditional medicines are derived from medicinal plants, minerals, and organic compounds (Barkat et al., 2021). The Committee of diabetes experts of the World Health Organization (WHO) recommended trading the largest barrier to herbal medicines and the lack of scientific and clinical evidence demonstrating its effectiveness and safety (Saggar et al., 2022; Syahri, Fariha, Afandi, & Nurliyana, 2024).

During the last few decades, it has been observed that millennia-old traditional herbals, treatments, and practices for many diseases are coming to the fore at an international level. Many such medical treatments, which have been practiced for thousands of years in indigenous cultures, are now subjected to standard research procedures to find their true healing powers, side effects, consequences etc. Diabetes is one of the most concerning diseases tested with AMTs in recent years due to the lack of permanent cure in allopathic medicine (Verma, Gupta, Popli, & Aggarwal, 2018; Yuan, Shanmugam, Ren, Nian, & Shuhili, 2024). The treatment methodologies, herbals and other materials used in various cultures differ significantly and none of the previous studies have given prominence in critically investigating these diversified techniques. The high cost of side effects of chemical drugs leads to improper use of drugs, non-admission of patients, and, as a result, impaired strict control of the disease. Various studies have reported that the reasons for using complementary medicine by patients include: maintaining good physical and mental health, prevention or treatment of musculoskeletal disorders, allergies, respiratory problems, cancer, chronic diseases such as diabetes mellitus, and weight loss. This paper makes a comprehensive analysis to fill the research gap. Firstly, discuss AMT trends in Web of Science repositories, such as the number of publications in a different area and future trends, then explain the different types of diabetes with signs in the body, followed by reviewing different traditional medicine in Chinese and Indian communities and other parts of the world. In addition, sections 4 and 5 review the most common herbal, then discuss challenges and preparation and end recommendations for future study.

2. Literature Review

2.1. Alternative Medical Treatment Trends

The number of publications collected from the Web of science repository in the last five years using the following keyword: Alternative Medical Treatment, Diabetic Therapy, Herbal Medicine, Acupuncture method, Meditation method, Yoga, Nutrition shows that a total of 56027 papers published between these years. The number of publications per year is shown by read line, and the total number of publications by the end of 2021 is around 13000 papers. The number of publications is based on area categories, including herbal medicine, food medicine, Activity and other alternative methods such as accoucheurs, yoga, meditation, etc. From the figure, it is clear that researchers are using more herbal and traditional treatments besides activities and food nutritions. Based on the funding, the number of publications on herbal medicine treatment is around 4400 papers followed by around 4000 for accupunchers, meditation, yoga, etc. On the other hand, the number of publications on nutrition and exercise activity is 2350 and 1958, respectively. In these years, the number of publications will be increased, especially on using herbal medicines. So, this is an important overview for the government and policymakers to do a necessary activity to support AMT in research and development and increase the lack of knowledge to protect people with diabetes(Rezadad & Maghami, 2014; Yaghoubi, Yaghoubi, Maghami, & Jahromi, 2025).

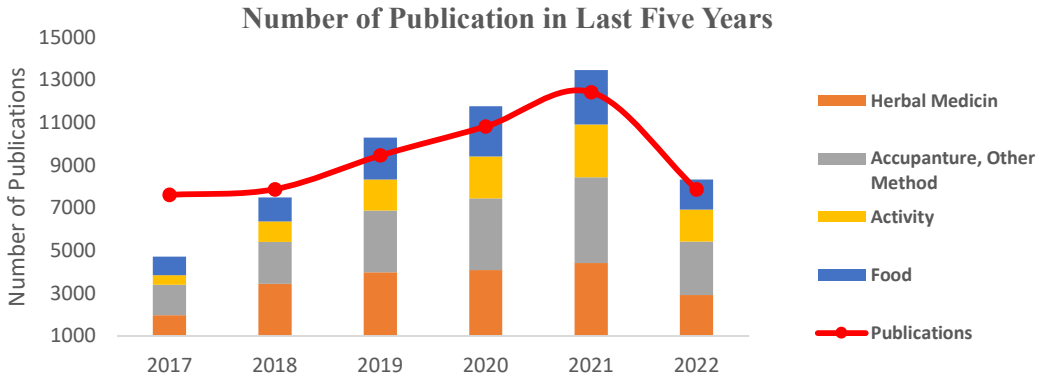

Figure 1. Number of Publication in field of Alternative Medicine Treatment in Web of Science

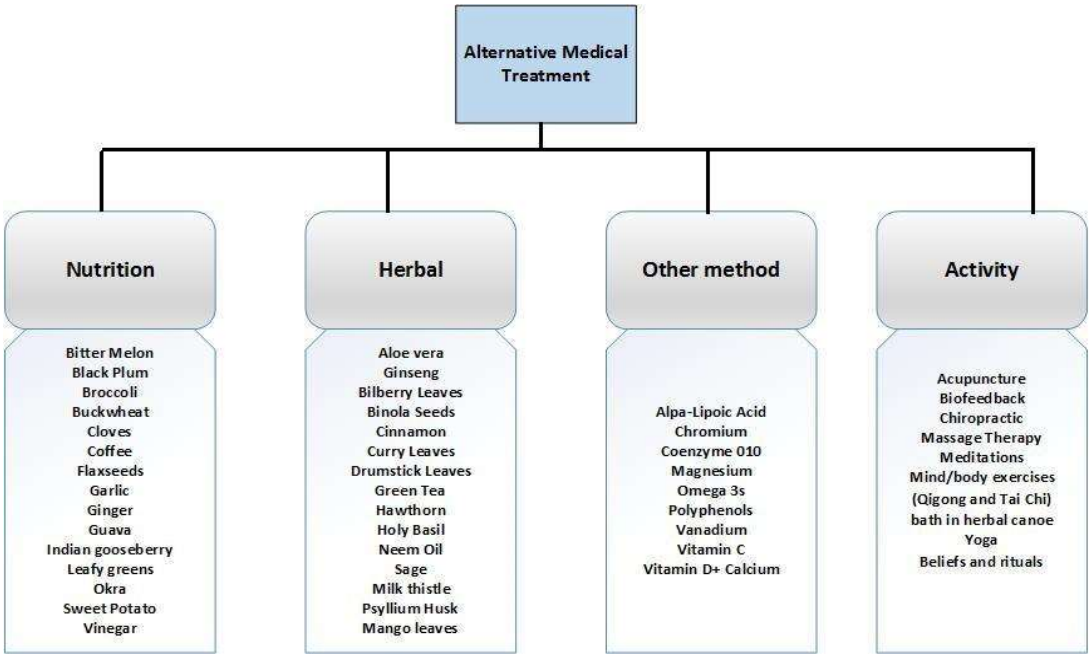

Figure 2. Alternative Medicine Treatment areas categories based on Web of Science (WOS)

2.2.Type of Diabetes

Basically, diabetes is the body not making enough insulin or not using it well. As a result of this disease, sugar cannot be absorbed into the cells from the blood(Verma et al., 2018). This increases the amount of blood sugar. Glucose is a type of sugar that's found in the blood and is a major source of energy in the body. When the body has a low level of insulin or the body cannot use it, sugar builds up in the blood. People with diabetes are at high risk for high blood pressure, peripheral vascular disease, and coronary heart disease. Diabetes affects all body systems, including the immune system, so these patients are three times more likely to die from Covid 19 (Holder & Reddy, 2021). There are various diabetes types(Verma et al., 2018), including Type one, Type two and Gestational diabetes. According to the number of publications found during the last five years, most of them discuss diabetes type two, which is more common worldwide. According to figure 3, 69 percent of publications discuss type 2, follow by type 1 with 24 %, and Gestational diabetes with 7% publications.

2.2.1. Type 1 Diabetes Symptoms and Consequences

Diabetes based on insulin also often happens in children and teenagers (DiMeglio, Evans-Molina, & Oram, 2018). In this type of diabetes, the pancreatic beta cell responsible for making the hormone insulin in the

body are destroyed or inactivated. These patients must be given lifetime insulin to regulate blood sugar. Diabetes of type 1 patients must learn to measure their blood sugar frequently and change the type and quantity of insulin as needed(Beck, Bergenstal, Laffel, & Pickup, 2019). Type 1 diabetes is caused by stress, lack of exercise, poor diet, and lack of insulin in the body. The following symptoms occur, such as severe thirst, increased volume of urine and nocturia, and increased overeating with an increased risk of infection. In Type 1, there are two categories: short-term and long-term diabetes. In the case of short-term diabetes, some issues can arise such as Hypoglycemia, Hyperglycemia, Ketoacidosis of diabetics, PED, Foot diabetic ulcers, and more. While much is still unknown about diabetes, there's one thing that's certain: long-term high blood sugar puts everyone at greater risk from a variety of health issues, including eye, kidney, nerve diabetes, and disease of the heart and stroke. Table 1 summarizes the cause, symptoms, and treatment of diabetes type 1(DiMeglio et al., 2018).

2.2.2. Type 2 diabetes (T2D) Symptoms and Consequences

Non-insulin-dependent diabetes may occur more often at 40 years of age or older. In this kind of diabetes, patients' insulin levels are usually high, showing a decrease in body cell sensitivity to insulin. Since most people with T2D are obese, obesity is believed to decrease the body's insulin sensitivity(Berbudi, Rahmadika, Tjahjadi, & Ruslami, 2020). T2D is a metabolic disease that can be prevented by lifestyle modification, diet control, and control of overweight and obesity. People need to be educated to prevent the spread of this epidemic. As indicated in a recent study by Jonatan Jafet (Uuh Narvaez & Segura Campos, 2022), the potential of Maya plant foods as nutrients or functional meals might assist explore novel dietary treatment approaches to avoid T2D. Nutritional and functional properties of plant foods from the Mayan diet could inspire new strategies to prevent disease and boost health and wellness as an alternative to the Mediterranean diet. Table 1 shows the causes and symptoms of different types of diabetes type 2 (Berbudi et al., 2020).

2.2.3. Gestational Diabetes

The insulin-inhibiting hormones are generated during pregnancy in a female body; therefore, pregnant women can develop diabetes (McIntyre et al., 2019). During pregnancy, the body produces larger amounts of some hormones such as human placental lactogen and hormones that increase insulin resistance. The most common causes, symptoms, and treatments of this type of diabetes are summarized with others in table 1. The finding shows that women with the following sign have more risk to get this type of diabetes, women who have Body Mass Index (BMI) above 30, previously had a baby who weighed above 4.5 kg at birth, or one of her parents or siblings has diabetes. This may be caused by the baby growing larger as usual, which leads to difficulty during delivery and increases the likelihood of needing induced labor or a cesarean section. Another effect may occur a baby develops low blood sugar or yellowing of the skin and eyes after delivery, which may necessitate a cure in the hospital. In addition, increasing amniotic fluid in the womb can cause premature labour or problems at delivery. Recent research in 2021 study overviewed the medical plant of gestational diabetes, which discusses the effect of medicinal plants and the result of plant diet on this type of diabetes (McIntyre et al., 2019).

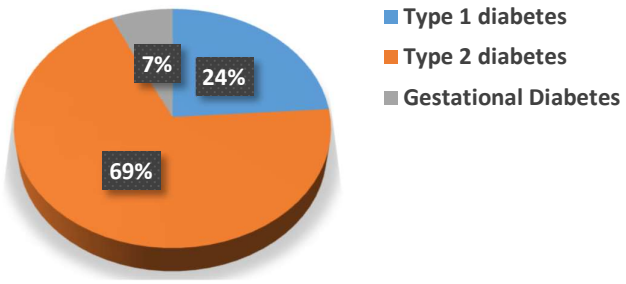

Figure 3. Number of Publications based on type of diabetics

Table 1. Comparison different type of diabetes

Type	No-Papers	Cause	Symptom	Consequence	Treatment
Type1 (Beck et al., 2019; DiMeglio et al., 2018)	13450	Genetic factors Infection with specific viruses	Fatigue & Weakness, Bed-Wetting in Child, Hunger, Weight Loss, Frequent Urination, Blurry Vision, Increased Thirst Unintentionally,	Nephropathy (kidney disease), Infections of the skin and gums , Symptoms include heart disease, stroke, hypertension, nerve damage, foot trouble, Retinopathy (eye disease)	Insulin
Type 2 (Berbudi et al., 2020; Uuh Narvaez & Segura Campos, 2022)	38867	Obesity Inactivity age over 40, Improper diet Heredity	Weight loss, Dry mouth, Polydipsia, Headaches, Fatigue, Yeast infections, Hyperplasia Blurry vision, tiredness, slow-healing sores, increased hunger, thirst, urination	Over time, high blood glucose can damage your small blood vessels. Blood vessels that are damaged don't deliver blood well, so other problems come up, especially with your eyes, nerves or kidneys	Diet and exercise If lifestyle change
Pregnant (McIntyre et al., 2019)	3890	Overweight	Feeling thirsty. Fatigue from drinking more than usual. Tired even more than usual. Mouth feels dry.	Endangering the health of the fetus Incomplete fetal birth, Increased of cesarean Overweight at birth, Having a preterm baby , Syndrome of respiratory distress, Blood sugar low at birth	Exercise and light physical activity

2.2.4. Socio-psychic Reasons for Following AMT for Diabetes

Because AMT has existed for millennia, there is a great deal of confidence in some countries' public. In recent years, the number of herbal medicines has increased significantly and these medicines are common in developed and industrialized countries due to their natural origin and fewer side effects (Verma et al., 2018). There are many traditional medicines made with herbs and biotech. People with diabetes use conventional medicine, which shows that patients face diabetes problems and decisions. Patients tend to go to hospitals to cure themselves, which are costly and require a special diet. Diabetic medicines are often unavailable in hospitals; maybe every patient receives an average of 4 prescriptions daily. Although a number of Western medicines are now available for treatment, treating diabetes with inexpensive drugs is still a major challenge. These medicines sometimes have negative effects, including increased risk of heart disease, obesity, and bone loss. The negative effects can get worse with continued use. In addition, due to T2DM's chronic nature and long-term medication requirements, treatment is also very expensive. Herbal medication for the community and for some people with diabetes is suitable, accessible, cheap, and convenient. Herbal cures may be a good substitute or a Western medicine replacement (Mogre, Johnson, Tzelepis, & Paul, 2019).

Reports from the WHO show that one-third of the world's population has almost no access to modern and essential medicines, and nearly half the people in Africa, Asia, and Latin America is experiencing a shortage of basic health care. Health care studies in developing countries consistently show a lack of government health funding, leading to very limited health and human resources. This reflects the apparent inequality in health carefulness delivery in the developing world. In several developing countries, external health care resources have been a major barrier to achieving optimal health outcomes. In order to achieve optimal health outcomes, the WHO acknowledges that low literacy and income levels, socio-cultural beliefs and practices, and, most importantly, the optimal use of health services are the main constraints. In addition, health workers mentioned that patients with diabetes have difficulty obtaining biomedical medicines owing to traditional herbs. Several reasons can prevent patients from getting the medicines, such as financial issues that keep them from obtaining them in a drugstore, or lack of independence to obtain these medications at a facility. They have been buying these biomedicines in their private clinics, but if they don't have enough money, they prefer to use AMT. Despite the fact that the medical plant is expensive, it is at least given in large quantities. The patients can buy jerry, but the insulin bottle (about 6$) will last a couple of days. Also, they think it's cheaper, more psychologically reasonable, and has a bigger quantity.

Medical medicine is compatible with the traditional treatment because it is easy to use. This herbal medicine is beneficial because it can be used even when the biomedical dose is taken. Many patients with diabetes reported using herbs rather than medications when they visited the hospital. According to health experts and herbalists, the herbs were easily accessible. Just like biomedicines, these drugs were even easier to administer because patients did not fear overdosing. Patients have no specific dietary guidelines for herbs. In addition, community members supported and accepted the use of plants. Figure 4 shows the socio-psychic reasons for following alternative medical treatment.

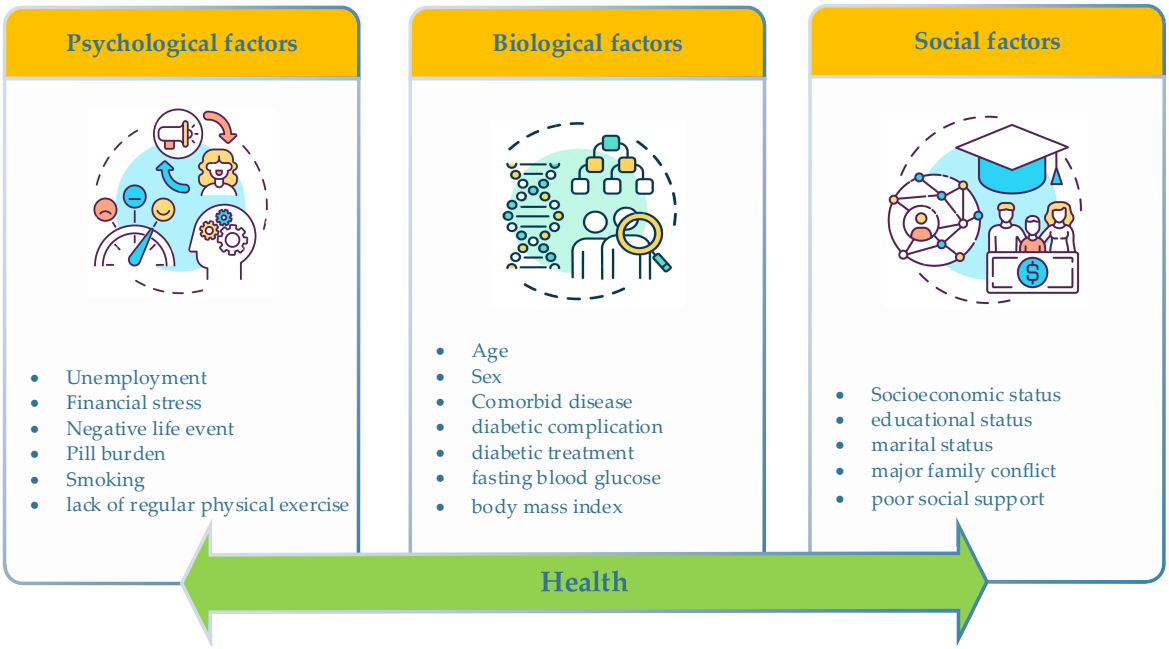

Figure4. Socio-psychic Reasons for Following AMT

2.2.5. Alternative Medical Treatment Around the World.

There is no definitive cure for diabetes, but complementary therapies are the goal of research groups to reduce complications (Xiao & Luo, 2018). Researchers show that countries such as China have the highest production and use of medicinal plants, followed by the United States, Hong kong, India, Japan, Germany, South Korea, France, Taiwan, and Spain. Traditional Chinese medicine (TCM) looks in a

holistic manner at the human body and its activity (Lian et al., 2020). From this perspective, every body part or symptom is linked to the others. As opposed to Western medicine, which aims to identify separate entities or predisposing factors for a particular disease, TCM discovers maladaptive patterns that mask the signs and symptoms of all patients and the emotional and mental responses. Humans are viewed both as a reflection of and an integral part of nature, and health results from maintaining harmony and balance within and between the body and nature. In Southeast Asia, Unani, Ayurveda, Jamu medicine, Homeopathy, Siddha, Koryo medicine, naturopathy, Tibetan medicine, yoga, and Thai medicine are the prominent medical systems apart from the rich traditional medical practices (Organization, 2020). Among the Southeast Asian region countries, there are university-level programs for traditional, complementary and alternative medicine (TCAM), national legislation, and research societies. TCAM has been introduced into public health in Myanmar, Thailand, India, Nepal, and, to a certain extent Sri Lanka. Whereas Maldives and Indonesia have not yet adopted them in their health systems, Korea, Nepal and Bhutan have initiated policies for integration. In many countries, due to the existence of powerful codified knowledge systems, traditional medicine does not have enough support, although it is widely used.

Herbal therapy is often the initial treatment for all diseases in African countries, particularly in rural regions(Ozioma & Chinwe, 2019). There are several reasons why traditional healers are commonly used, including lack of access to medical centers, insufficient roads/infrastructure, and affordability. Modern medicine is fully accepted in most African countries, but traditional medicine still holds great importance. A herbal therapy is believed to be both physically and spiritually beneficial. In Africa, treatment techniques that were most commonly used include Beliefs and rituals, Tribal practices, and African herbal medicine (Ozioma & Chinwe, 2019).

Clay types, minerals, herbals, and other treatment methods in Persian gulf and Arabic regions (Hasan, 2021). Several sources discuss the treatment of various diseases by herbal medicine [9]. Diagnoses are made based on the temperament of the whole body. The treatment involves changing the temperament's balance and imbalance. Several researchers consider some medical plants' effects on laboratory humans and animals. In (Rezaei, Farzadfard, Amirahmadi, Alemi, & Khademi, 2015) investigated, some Iranian medical plant compounds for diabetes treatment mellitus, and some research articles assessed the effects of hypoglycemic herbs. Arabic gums are components of dried resins of the antidiabetic plant composition of traditional Iranian medicine (Mehrzadi, Tavakolifar, Huseini, Mosavat, & Heydari, 2018). The polysaccharide does not digest in the intestines, but in the large bowel, it produces short-chain fatty acids; as a result, it has extensive biological effects. Also, the extract of A. arabica increases insulin release and has anti-diabetic effects (Fattaneh, Mohammad, Asieh, & Mehri, 2012). Researchers found that Arabic gum powder granules significantly reduced blood sugar in healthy rabbits, but not in diabetic rabbits induced with alloxan. Additionally, Wadood et al. (Wadood, Wadood, & Shah, 1989) found that oral administration of Arabic gum aqueous extract significantly reduced blood sugar, cholesterol, and triglycerides in diabetic rats. Base on the scientific record the US and China has the highest number of scientific research of AMT(Figure 5).

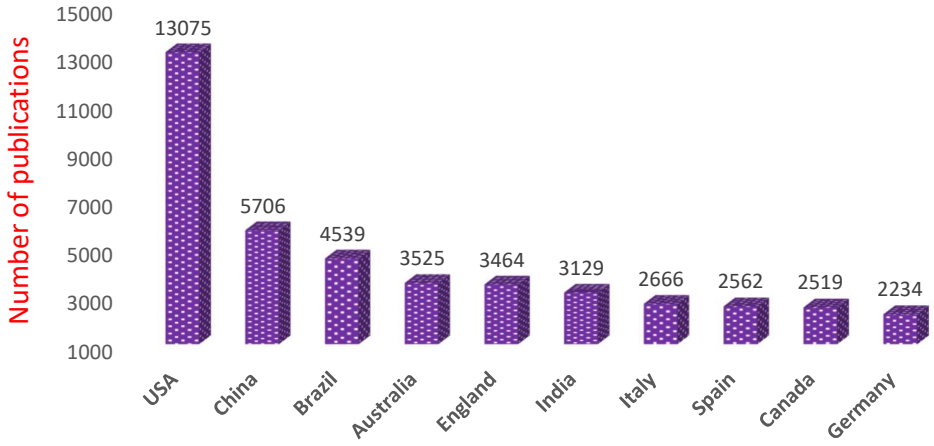

Figure 5. Top ten countries with the high number of research on AMT

3. Alternative Medical Treatment Approach

Traditional medicine was developed thousands of years ago as a healing technique. It has become a popular and cohesive medication system using various methods for treating and preventing diseases. In Traditional Medicine, the most commonly used treatment techniques include acupuncture, Chines massage (Tui Na), Chinese herbal medicine, diet treatment, Qi gong, and Tai Chi(mind/ body practices) (Koithan, 2009; Marshall, 2020; Micozzi, 2014). Studies on diabetic patients show that complementary therapies used in these patients include diet and lifestyle, herbal medicines containing antidiabetic agents, magnetic therapy, mind and body exercises, massage therapy, and music therapy.The following section describes the most common medical herb:

3.1 Acupuncture

This treatment involves inserting very thin needles deep into the skin at specific points in the body in order to induce healing (C. Chen et al., 2019; Zhang & Ye, 2010). The research shows that it can help relieve pain and is used for many other complaints. Zahang et al [27] purpose to observe the clinical effects of acupuncture on diabetic peripheral neuropathy. Recent research evaluated the efficacy of acupuncture analgesia on 46 patients with painful peripheral neuropathy. A study in 2007 reported significant improvement in symptoms in 34 patients (77%) using TCM acupuncture points (Wazir et al., 2019). It has been found that, after a follow-up period of 18-52 weeks, 67 of those who were present had been able to discontinue or significantly reduce their use of pain medications. It took only 24 percent more acupuncture to get rid of their symptoms, while 24 percent said they were completely cured (Liao, Xi, Chen, Yi, & Zhao, 2007). Tsai et al (T.-Y. Chen, Wen, Dai, & Hsu, 2021) investigate on acupuncture to assess the efficacy and safety of acupuncture for Type 2 diabetes. Biomaterials based on cryogel/hydrogel and acupuncture are combined for diabetic skin wound healing. Combining stem cell-seeded cryogels and hydrogels with acupuncture had synergistic immunomodulatory effects. Using biomaterials, stem cells, and acupuncture in conjunction with each other reveals potential for a unique approach to accelerate the regeneration of tissues. Bianca et al (de Assis et al., 2021) study evaluating auricular acupuncture's effects on diabetic foot risk factors.

3.2 Moxibustion

Moxibustion is a traditional Chinese medicine treatment that involves burning dry maggots (wikt: moxa) in specific areas of the body (Unschuld, 2019). It is significant in the traditional medical systems of China, Korea, Japan, Mongolia and Vietnam. Traditionally, Moxibustion is used for diabetes treatment to minimize blood glucose and to normalize the endocrine system. It is possible to perform moxibustion directly, directly without scarring, or indirectly. The direct method of moxibustion involves applying the

moxa cone directly to the skin around the acupuncture point, as opposed to the indirect method, where insulating materials (like salt or ginger) are placed between the moxa cone and the skin. Direct moxibustion does not leave scars on the skin, and the acupuncturist removes the burning moxa before the skin starts to burn sufficiently to scar, unless the burnt moxa is left on the skin for too long [10]. Indirect moxibustion involves heating the skin with moxa cigars that are held. Or, moxa cigars are put on acupuncture needles to provide heat [10] There is also stick-on moxa (Tan et al., 2020). This approach has been widely used by researchers, particularly among diabetes patients suffering from insomnia and improving their sleep quality significantly. Moxibustion has a positive correlation with its therapeutic effect and its therapeutic effect is enhanced by moxibustion time.

3.3 Mind/body exercises (Qigong and Tai Chi)

Mental interventions or exercises can improve the function and health of the body because of the impact of the nervous system on the system and immune system (MB system). The most common exercises are Tai Chi, Yoga and Qigong. In Qi Gong, the term refers to the connection between the body and mind (Yeung, Chan, Cheung, & Zou, 2018). The goal of the practice is to balance, harness, and enhance Qi through breath and body movements. In addition to promoting health, Qi gong promotes healing, spiritual growth, and happiness. It has been found that Qigong is an effective adjunctive therapy for diabetes, even though it is not commonly used as a major treatment modality. Putiri et al (Putiri, Close, Lilly, Guillaume, & Sun, 2017) Diabetes can be managed with specific Qigong exercises. Meng et al (Meng, Chunyan, Xiaosheng, & Xiangren, 2018) investigate the impact of Qigong in management of diabetic among 1326 patients and the result show the improvement on T2D. Yoga and breathing exercises cause a lower heart rate and blood pressure than those who did not practice yoga. In a qi-gong intervention, improvements were found in weight, waist circumference, leg strength, and insulin resistance.

3.4 Chinese massage (Tui Na)

This Chinese massage consists of pulling, kneading, pushing, and grassing the body to stimulate acupuncture points and other body parts to achieve balance and coordination. In patients with an aversion to needles, especially pediatric patients, can be used effectively instead of acupuncture (Li et al., 2020). Tuna massage unblocks blockages and disturbances in the body's yin and yang, which can manifest as illness, disease, and emotional problems. Similarly to acupuncture, Tiuna massage balances your qi and blood through energetic meridians and acupoints. If qi isn't flowing correctly, it can cause blockages, like poor blood circulation. Several massage techniques are used in Tiuna massage, including acupressure, myofascial release, and reflexology. The technique can include stretching and joint mobilization, which are common to osteopathy and chiropractic.

3.5 Five Element Theory

Wu Xing's theory of five phases classifies phenomena in five basic processes described by water, wood, earth, fire, and metal elements (Lee, 2020). Each element is linked to an organ of the body in the five-phase model. Elements interact in predictable behaviors in nature as well as in the body. Wood is associated with the liver and Gallbladder. It tastes sour, and the smell is rancid, like oil that has become bad. Fire is related to the Heart, small intestine, heart protector, and triple heater. the fair has a bitter test, and it smells like burnt sulfur. Earth is associated with the spleen, pancreas and stomach; its taste is sweet and its scent is fragrant. Metal with the lungs g and Large Intestine. The taste of the metal is spicy or pungent, and its smell is rotten. Water is associated with the kidney and Bladder. The test of water is salty, and its scent is putrid. In addition, every element is linked to other phenomena like seasons, cardinal directions, temperature, color, and emotions. Diagnostic information is obtained within the TCM model by identifying patients' favorite seasons, colors, and emotions.

3.6 Yoga Exercise

It is important to know that many different types of health knowledge are available, including yoga, tai chi, judo-siphoku, qigong, meditation, kalari breathing techniques, massage techniques, and many more.

Even though these aren't medical systems, they play an important role in the health sector by being adapted as health applications (Jayawardena, Ranasinghe, Chathuranga, Atapattu, & Misra, 2018; Raveendran, Deshpandae, & Joshi, 2018). An ancient Indian practice, yoga combines mind, body, and emotion to balance and harmonize them. Various lifestyle diseases, such as T2D, can be managed through yoga practice. In study (Raveendran et al., 2018) consider the impact of yoga on diabetes type 2. In their review, they summarize evidence from numerous clinical studies regarding the role of yoga practices in diabetes management.

3.7 Indian massage and oil treatment

Massage with oil is a key component of Ayurvedic treatments(Gordon, Buch, Baute, & Coeytaux, 2019). Its calm approach creates a relaxed state that improves sleep patterns and helps recipients feel better. Ayurvedic massage should be performed daily in an ideal world to help maintain our bodies and minds from being adversely affected by everyday stresses and strains (Bhamre). Newborns have been massaged with oil for centuries in India. In Indian subcontinent, people have routinely applied natural oils to newborns' skin for hundreds of years. There have been a number of oils used for this purpose. Oil massages were given to the head, neck, trunk, and extremities in both prone and supine positions. Kinesthetic stimulation followed the massage in a supine position with passive flexion and extension movements of the limbs at each large joint (hip, shoulder, ankle, knee, elbow,) every 2 seconds. Mathai et al. described the massage and stimulation procedure(Gordon et al., 2019).

3.8 Medicinal bath (bath in herbal canoe)

Another popular way in Indian culture is using the herbal bath for medical purposes. Herbal bath powder is a natural powder with many medicinal properties and benefits and is very famous in Tamil Indian Culture(Lin, Xu, & Shangguan, 2014). The use of many herbs was widespread among Indians, which is indicated by many research papers. Skin absorbs chemicals from them. Such chemicals mix with body molecules and cause a few skin-related side effects. But when products made using various medicinal herbs are applied on the skin, the medicinal and healing properties of the herbs enter the body through the pores of the skin. They cleanse the skin and heal and nourish the body. Avoiding soaps with chemicals can prevent excess chemicals and toxins from entering the body. In a study published in the journal Diabetes Care, researchers found that passive heating, such as hot baths, can help people burn more calories and prevent blood sugar spikes after eating(W. Chen, Luo, & Liu, 2011).

3.9 Meditation and psychological treatment

Meditation reduces stress, lowers blood sugar levels, and decreases the risk of cardiovascular disease in diabetic patients. Meditating for 10-15 minutes can reduce stress and regulate blood sugar (Priya & Kalra, 2018). In meditation, the body experiences an immense sense of peace and calm induced by the mind staying calm and silent, and being aware of the surroundings simultaneously. Although its origins are unknown, it has been around for thousands of years. It is undeniable that Buddha played an important role in spreading the practice of meditation throughout the country. After Buddha attained enlightenment under the Bodhi Tree, Hindu and Buddhist meditation began to differ. Hindus used meditation to understand God, but Buddhists used it to understand one's relationship with everything. Tourists from all over the world have been flocking to India, in particular, in recent years. Gurus and experts in this field of study have set up various meditation centers in different parts of the country. The success of these centers is largely due to the difference meditation has made in people's lives. Meditation releases catecholamine, which reduces stress hormones. Additionally, meditation may help decrease insulin resistance and high blood glucose levels in your body by decreasing cell-damaging oxidative stress, Enhancing immune system function and immune system function (van Son et al., 2015).

3.10 Beliefs and rituals

In the African world, everyone gets sick for a reason. Diseases are seen as punishments for individuals and communities, according to their beliefs(Ayele, Tesfa, Abebe, Tilahun, & Girma, 2012). There is a debate

between good and evil, and it is expected that good will win in the end. In the societies where the gods and ancestors play an important role, those who violate the moral order of society may face punishment from the gods and ancestors. Doctors try to find the cause of an illness via mystical and cosmic communication when they get to the sick person's bedside. In some cases, diagnosing the disease is easy, while in other cases, it may be more difficult to do. Whenever he can't make a prediction, he asks the sick person's relatives to consult a prognosis to see what's causing it and how to fix it. Medications and sacrifices are prescribed for effecting cures when the spirit world is consulted by divination. In most cases, sacrifices are required since the victim is guilty. Man is not merely physical; he has also a spiritual aspect (soul), which makes him a moral being capable of sin, and, consequently, subject to penalties in the form of suffering, and, in particular, sickness. In some cultures, there is a strong belief that the body and soul are interconnected and profoundly affect each other. Researchers have found that religious involvement improves attendance at medical appointments and medication compliance in chronic diabetes (Tom-Orme, 1994).

Table 2 : Overview Medical plant approaches for treatment of Diabetics

Ref	Methodology	Remark	Findings
(C. Chen et al., 2019; Liao et al., 2007)	Acupuncture	Patients with T2D can use self-acupressure effectively, safely, and cost-effectively to control their blood glucose levels, and can easily perform it themselves without a physician's intervention.	• Animal studies and clinical trials • Enhance blood glucose control • It's good for weight loss • Insulin-producing pancreas islets are protected • Insulin resistance is improved • Make sure hormones such as melatonin, insulin, glucocorticoids, and epinephrine are balanced
(Garcia-Vivas et al., 2014) 13	Moxibustion,	combination of acupuncture and moxibustion increases clinical efficacy. Moxibustion was applied to acupoints CV6, Qihai; CV4, Guanyuan, ST36, Zusanli;DU4, Mingmen	• T2D patients can get better sleep with moxibustion therapy, there's a positive correlation between the therapeutic effect and the amount of moxibustion time. • Moxibustion can help with improving the therapeutic effect of moxibustion, too.
(West, 1973)	Diet therapy	A diabetes diet is a healthy-eating plan that's naturally rich in nutrients and low in fat and calories. The foods we eat provide us with nutrition. Macronutrients are essential for the human body because they provide energy that can be burned or stored. Protein, carbohydrates, and fat are the three essential nutrients. Each gram of carbohydrate and protein contains 4 calories and each gram of fat contains 9 calories.	• Maintain near-normal blood glucose levels. • Achieve optimal serum lipid levels. • Achieve and maintain a reasonable weight for adults. • Balanced nutrition & positive outcomes for pregnancy & lactation. • Prevent & treat acute complications such as hypoglycemia and short-term illnesses. • Make sure food, medication, and exercise are all in balance. • Prevent, slow the development of, or treat co-morbidities such as hypertension, • Optimize your health with balanced nutrition
(Liu, Miller, Burton, Chang, & Brown, 2011; Raveendran et al., 2018)	Mind/body exercises Yoga Exercise	Exercises such as yoga and breathing cause a slower heart rate and lower blood pressure than those who do not practice yoga. Improvements in weight, waist circumference, leg strength, and insulin resistance were associated with the qi-gong intervention,	• Diabetes can be controlled with weight loss, according to mediation analyses. • Stress reduction; Enhancing emotional well-being; Boosting strength & balance; Preventing heart disease;

(Bayat et al., 2019)	Chinese massage Indian massage Swedish massage; Connective tissue massage; Aromatherapy; Compressed air massage	Massage effect consider on different age, different part of body, combined with other method. Consider on type 2	According to the related articles, significant results were obtained, including a ↓ in blood glucose levels and hemoglobin A1c levels as well as improvements in neuropathic pain and diabetic foot ulcers. ↑Quality of life: Scale of role functioning, physical; ↓Cortisol, ↓PR, ↓Adrenaline; ↓HbA1C, ↓FBS; ↓ Waist circumference; BS2HPP↓, Symptoms index↓ ↓Neuropathic pain, quality of life ↑; ↓Treatment duration (foot ulcer)
(Wu, Tai, & Sun, 2019)	Medicinal bath	Researchers suggest that passive heating, such as a bath, may decrease insulin spikes after eating by increasing the rate at which people burn calories. People with T2D may benefit from these findings long-term by losing weight and controlling their blood sugar.	The bath ↑ energy expenditure by 80 percent, which isn't as high as exercise. As a result of the hot bath, they burned an average of 126 calories per hour, equivalent to about 25-30 minutes of walking.
(Schuster, 2010)	Meditation	By meditating, you'll be able to relax in a new way and learn new tools for dealing with stress. All of us experience stress in our lives at some point during our lives. Diabetes patients face two problems from stress: It directly raises their blood sugar levels, and they're more likely to engage in unhealthy behaviors when stressed. We may tend to eat more high-carbohydrate foods, or sit on the couch and watch TV instead of exercising. Stress has the tendency to make us less disciplined and more self-indulgent than we normally would be.	Meditation helps diabetic patients by ↓ stress, ↓blood sugar levels and ↓ the risk of cardiovascular disease. The breathing technique helps in better exchange of oxygen and carbon dioxide in every breath. This leads to better cellular metabolism, a function that is impaired in diabetic patients due to insufficient release of insulin. Insulin regulates blood sugar flow into the body's cells from the bloodstream.
(Watkins, Quinn, Ruggiero, Quinn, & Choi, 2013)	Beliefs and rituals		Using herbal therapy is more likely if patients have low self-care and high beliefs. By providing individualized diabetes education, influence a patient's beliefs and encourage self-care.

SBF=skin blood flow; TM=Tactile Massage; SAP=segmental arterial pressure; HbAlc=glycated hemoglobin A1c; SM=Swedish massage; PR=pulse rate; CTM=Connective tissue massage; CM=Chinese massage; AM=Aromatherapy massage; BCC=bacterial colonization count; WAR=wound area reduction; RCT=randomized controlled trial; DM=diabetes mellitus; FBS=fasting blood sugar; Cam=Compressed air massage; MCT=medium chain triglyceride;

4. Medical Plants for the Treatment of Diabetics

The WHO around the world lists 51,000 medicinal plants. Among them, 8000 species have been found in China and India, of which 350 species are commercially used on a fairly large scale. TCM and Indian herbs have been suggested for a wide range of herbal remedies for diabetes and diabetic side effects along with antidiabetic drugs and beneficial effects. In this study, the plants that were used in the treatment of diabetes are described below. It should be noted that the names of the plants mentioned in this text has been checked with MPNS (http://mpns.kew.org) on February 23, 2023.

An study in (Dewangan, Singh, Kumar Megh, Singh, & Lakshmi, 2022) describes the study of *Gymnema sylvestre* (Retz.) R.Br. ex Sm. that is the same as *Gymnema sylvestre* in the family Apocynaceae and grows in the tropical climate such as Central India, Southeast Asia countries and many countries in Africa. Indian and Chinese ancients used the leaves of *G. Sylvester* to cure diabetes, hypercholesterolemia, knee pain, and snake bites. The leaves of this plant are used by the tribal people of Tamil Nadu, India, in order to treat diabetes symptoms. The leaves are dried and powdered, and given orally to the diabetics as a remedy (Sehajpal & Verma, 2022). This plant is commonly called gurmar, due to its sweet-destroying properties as a result of its phytoconstituents like triterpenes gymnemic acids, gymnema saponins, and gurmarin. It contains glucose, tartaric acid, gurmarin, stigmasterol, gymnemic acid, calcium oxalate, betaine, and choline which provide the plant's anti-diabetic, anti-obesity, and anti-inflammatory properties(Tiwari, Mishra, & Sangwan, 2014). As a possible explanation for its hypoglycemic effects, it can be attributed to its ability to regenerate islet cells as well as inhibit glucose absorption through the intestinal wall. In addition, it enhances glucose utilization in the body and increases enzyme activity (phosphorylase enzyme), which contribute to glucose utilization (Kanetkar, Singhal, & Kamat, 2007). Several studies have shown that G. sylvestre stimulates the pancreas, resulting in an increase in insulin production (Shenoy, Prashanth, & Manonmani, 2018).

The plant *Coccinia grandis* (L.) Voigt is known for its anti-hyperglycemic properties as well as its medicinal role in the treatment of diabetes. A study by Gurukar et al (Gurukar, Mahadevamma, & Chilkunda, 2013) shown that he fruits of this plant improve albumin excretion, kidney index, urine sugar, glucose tolerance rate, and antioxidant enzyme levels in diabetic rats. According to several studies on diabetic rats, C indica leaf extract contains antiureogenic, antihyperglycemic, antioxidant, hypoglycemic, and hypolipidemic effects (Shibib, Amin, Hasan, & Rahman, 2012). According to (Kamble, Kamlakar, Vaidya, & Bambole, 1998), dried extract of C indica (*C. grandis*) improved insulin mimicking activity by correcting elevated enzyme activity in the glycolytic pathway (G-6-p (ase) and LDH) and by restoring LPL activity in the lipolytic pathway. It was found that the methanolic extract of this fruit exhibited an in vitro aldose reductase inhibitory activity of 96.6% with an IC 50 value of 6.12 g/ mL against completely purified bovine lens aldose reductase. It is believed that this activity is caused by the high levels of phenolics and flavonoids in the fruit.

Another plant which is used in India is *Allium sativum* L. (garlic) and contains non-protein sulfur amino acids with medicinal properties. It is a powerful herb that can treat a range of diseases such as tumors, headaches, intestinal worms, diabetes, fungal diseases ,parasites, cancer , and heart disease and insect bites (Wilson, Pandya, Mankad, & Solanki, 2019). A sativum extract and glibenclamide improved hypoglycemic effect in streptozotocin-induced diabetic rats (Ovesná, Mitrová, & Kučera, 2015; Poonam, Prakash, & Kumar, 2013). Researchers found that there was an improvement in glycemic control and antihyperlipidemic effects with combined metformin and garlic supplementation in diabetics patients (Ashraf, Khan, & Ashraf, 2011). Using fresh garlic homogenate (250 mg/kg) for 6 weeks improved antioxidant status in a streptozotocin-induced diabetic Wistar rat model (Naderi et al., 2015). In STZ-induced diabetic rats, garlic extract led to a reduction of blood glucose concentration and a downregulation of angiotensin AT1 receptor expression in the adrenal

and renal tissues. This explains why it can reverse the harmful effects of excessive Ang II signaling, which are manifested by hypertension and nephropathy (Mansour, Al-Qattan, Thomson, & Ali, 2013) . The effectiveness of garlic extract in controlling diabetes has been shown to be greater than that of glibenclamide (Eidi, Eidi, & Esmaeili, 2006).

Gua et al (Guo, Gao, Zhang, & Li, 2022) study about *Rehmannia glutinosa* (Gaertn.) DC. a member of Scrophulariaceae or Gesneriaceae family. Besides treating blood and immune problems, it treats endocrine, cardiovascular and nervous issues. In Chinese medicine, it's usually mixed with Radix ginseng, astragali and scutellariase (Yang et al., 2022). This combination also induced the secretion and proliferation of insulin cells by activating the insulin receptor substrate . Moreover, this treatment has been found to improve diabetes-induced foot ulcer healing in rats by stimulating tissue regeneration, angiogenesis, and reducing inflammation during the healing process. Postulated action mechanisms include stimulation of insulin secretion, glucose regulation in DM rats, and decreased liver glycogen levels in non-DM mice.

The *Syzygium cumini* (L.) Skeels tree grows in India, China, Indonesia and has been used extensively to treat diabetes mellitus in India (Ayenampudi, Verma, & Adeyeye, 2022). It can also be referred to as Eugenia jambalaya, Jambu, Black Berry, Black Plum, and Jamun among other names. Researchers found DM rats had lower blood sugar, postprandial glucose, cholesterol, and free fatty acids. As far as pharmacological properties are concerned, extracts of S cumini have been shown to inhibit -glucosidase activity. In DM animals, the liver enzymes, glucokinase, and phosphofructokinase, which play a significant role in the metabolism of glucose in the body, were drastically reduced in their enzymatic activities. Various tribes in Sikkim and Darjeeling Himalayas of India consume stem bark decoction for diabetes treatment. S cumini seeds extract significantly decreased blood sugar in rats induced with alloxan accompanied by increased body weight.

Stephania tetrandra S. Moore is an important herb used in TCM to reduce swelling and to have an analgesic effect (Z. Wang, Wang, & Chan, 2013). *S. tetrandra* root contains anti-inflammatory, allergenic, and hypotensive properties. One study found that *S. tetrandra* decreased blood glucose and increased insulin levels when combined with formononetin, one of the active ingredients in radix astragal. However, formaonetine didn't have a direct antihyperglycemic effect. Several researchers have concluded that *S. tetrandra* extract stimulates insulin release in the beta cells of the pancreas (Mashour, Lin, & Frishman, 1998).

Barringtonia racemosa (L.) Spreng, is a constantly-green mangrove that is used in Bangladesh, Sri Lanka and Western India for snakebites, rat poisoning, boils, and gastric ulcers (Umaru, Umaru, & Umaru, 2019). In addition, different extracts of the different parts of the plant contain different biological activities, with anti-DM, analgesic, anticancer, antifungal, antibacterial as well as anticancer properties. Berberis Aristata has been used as a plant tonic agent in South Asia for improving liver and heart functions. The main components of roots are known as Palmatine, Berbamine and Berberine. Extract B. Aristata (Root) has the potential to regulate glucose homoostasis by reducing gluconogenesis and oxidative stress (Jahan, Alvi, & Islam, 2022).

Guilandina bonduc L. is used by the Indian tribal population to control blood sugar. In chronic models of T2D, both aqueous and ethanolic extracts showed significant hypoglycemia (Chakrabarti et al., 2005). This extract increases the glycogenesis and raises the content of liver glycogen. The mango plant (*Mangifera indica* L.) is also a popular herb in India. In traditional medicine, this plant is used as an anti-diabetic (Samanta, Chanda, & Reddy, 2019). The blood glucose levels of normoglycemic or streptozotocin-induced diabetic rats were not affected by aqueous extracts when given orally. Nevertheless, when combined with glucose and given 60 minutes before glucose, the extract showed antidiabetic activity. *Phyllanthus amarus* Schumach. & Thonn. (bhuiawala) is traditionally used to treat diabetes. It has been shown that the methanolic extract of the

Phyllanthus amarus contains strong antioxidant properties (Patel, Tripathi, Sharma, Chauhan, & Dixit, 2011). As a result of this extract, the blood sugar levels of alloxan diabetic rats decreased as well. Also, the herb has antidiarrhoeal, anticarcinogenic, antimutagenic, and anti-inflammatory properties.

Traditional medicine in Iran uses *Rosa* × *damascena* Herrm (Damask rose) petals and essential oils. Acarbose (an alpha-glucosidase inhibitor) and methanol extract of R damascene have been compared between normal and diabetic rats, and the results showed that both potently inhibited alpha-glucosidase. Studies have found that 400 mg/kg of the hydroalcoholic extract from *Punica granatum* L. flowers significantly lowers blood glucose levels in diabetic rats (Jafri, Aslam, Javed, & Singh, 2000). Plantaginaceae are the plants that produce flaxseed plantain and psyllium seeds. In the seeds, bran and fiber delay the absorption of glucose and control blood sugar levels. There's also squash, which is grown in Iran and is mentioned in traditional medicine as a diabetes treatment. Studies using a polysaccharide banded with C pepo protein showed insulin serum levels rose, blood glucose levels fell, and glucose tolerance improved in diabetic rats. In Iranian traditional medicine, Aghaghia comes from a thorny tree called "Moghilan.". It is derived from the fruit of this tree and is known as Acacia (Aghili, Khorasani, & Shirazi, 2008). A study assessed Rumex patientia's hypoglycemic and lipid effects in streptozocin-induced diabetic rats. This showed that serum glucose, LDL, and HDL levels significantly decreased (Dabaghian, Kamalinejad, Shojaei, & Fard, 2012). *Aloe vera* (L.) Burm.f. is a traditional medicinal herb used treating tissue damage. Researchers found Aloe vera extract increases glucose tolerance in diabetic and normal rats (Rajasekaran, Sivagnanam, & Subramanian, 2005). From various medical plants around the world, different parts can be used to extract anti-diabetic properties as can be seen in Figure 6 more than 50 herb listed.

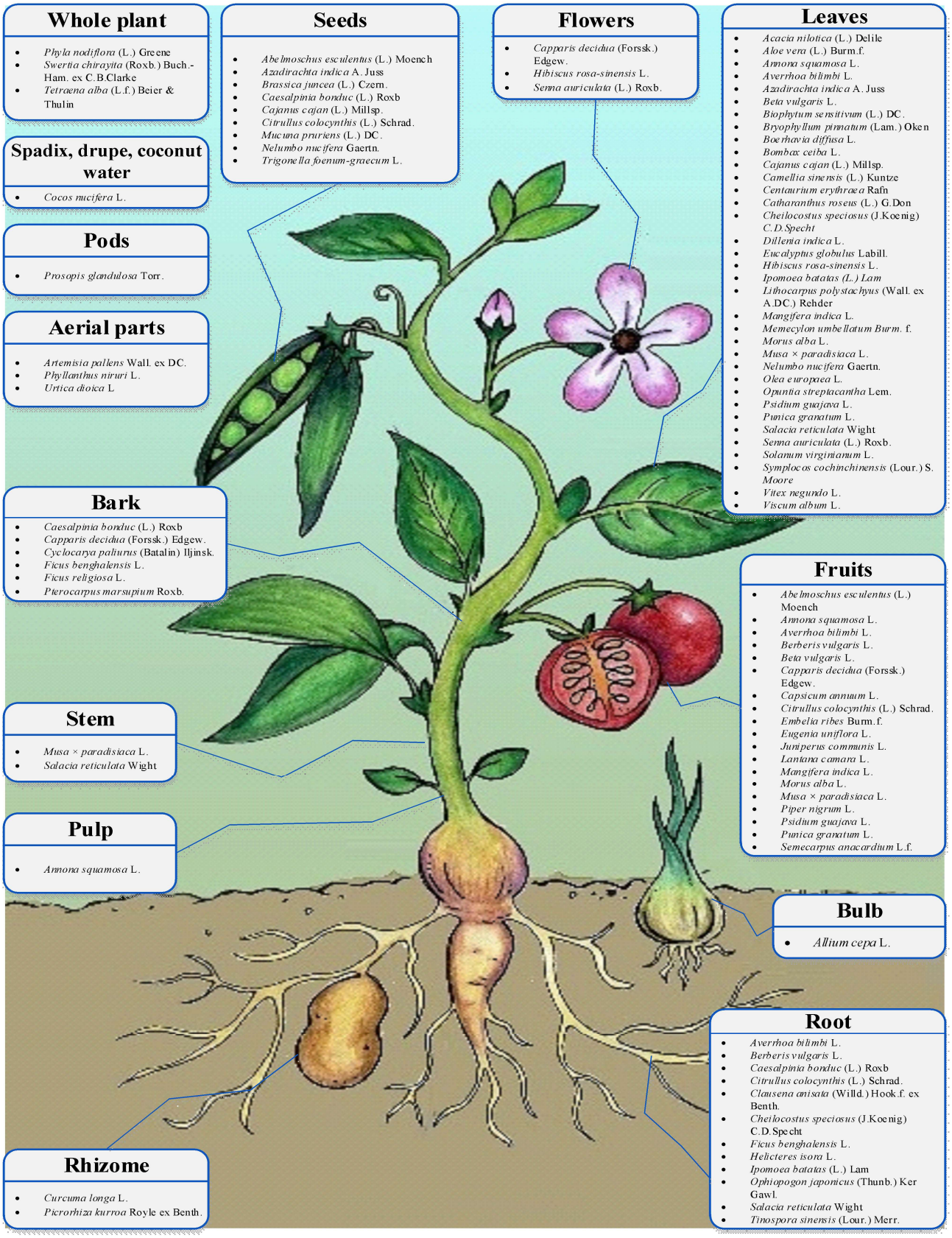

Figure 6. Medical Plant part use for treatment of diabetes

Table 3 Most common herbal medicine for treatment of diabetics

Ref	Name	Part Plant	Family	Location	Aim and objective/ findings
(Rao, Sreenivasulu, Chengaiah, Reddy, & Chetty, 2010; Tian et al., 2010)	*Swertia punicea* Hemsl.	Whole plant	Gentianaceae	America, Europe	Bellidifolin and methylswertianin ↓ FBG and FINS levels and enhance oral glucose tolerance.
(Widhiantara, Arunngam, & Siswanto, 2018)	*Guilandina bonduc* L.	Seed	Caesalpiniaceae Gray	India	C. bonducella seed extract appears to have anti-diabetic properties in animal models of T2D.
(Laha & Paul, 2019)	*Gymnema sylvestre* (Retz.) R.Br. ex Sm.	Leaf	Asclepiadaceae	India, Seri Lanka	Powdered leaves have been analyzed for their glucose-lowering properties. An investigation of 9:1 methanolic: water extract of GS leaves in normal and alloxan-induced diabetic mice showed statistically significant hypoglycemic activity.
(Rozenberg & Rosenzweig, 2018)	*Sarcopoterium spinosum* (L.) Spach	Root	Rosaceae	India, Bangladesh	Study objectives were to investigate how Sarcopoterium spinosum extract (SSE) affects diet-induced glucose intolerance and carbohydrate and lipid metabolism in mice on a high-fat diet (HFD) and mice on KK-Ay diets.
(Orgah et al., 2020; Qazi, Khan, Rizwani, & Feroz, 2014)	*Carthamus tinctorius* L.	Flower	Compositae	USA, India, Kazakhstan, Tonnes	Compared to diabetic control group, Carthamus tinctorius significantly ↓ blood sugar levels at 200mg/kg and 300mg/kg doses. Diabetes control and Glibenclamide treated groups had significantly higher insulin levels than diabetic groups.
(Basavarajappa et al., 2020)	*Coccinia grandis* (L.) Voigt	Leave/shoots	Cucurbitaceae	Asia, Europ	This study examines how Coccinia indica leaf extract (200 mg/kg p.o) protects rats from nephropathy caused by type-2 diabetes in combination with low-dose pioglitazone (7 mg/kg), while evaluating hypoglycemia as well.
(Zhu, Chen, Song, Wang, & Sun, 2018)	*Zingiber zerumbet* (L.)	root	ZingiberaceaeBitter	Asia/india	Using ginger extract ↓ diabetes-related cardiomyopathy's fibrosis and inflammation, possibly by regulating genes involved in the SMAD/TGF-β pathway.

	Roscoe ex Sm.				
(Deyno et al., 2019)	*Cinnamomum verum* J.Presl	Whole Plant	Cinnamomum	ww	T2DM and pre-diabetes patients with cinnamon showed ↓ FBG and HOMA-IR levels. Clinical trials should be done after cinnamon formulation is standardized because there's a lot of heterogeneity among included studies.
(Haghani, Arabnezhad, Mohammadi, & Ghaffarian-Bahraman, 2022)	*Aloe vera* (L.) Burm.f..	Leaf	Asphodelacea	Asia, Europ	Aloe vera is demonstrated as an anti-inflammatory, anti-hyperglycemic, and anti-hyperglycemic plant in this article on streptozotocin-induced diabetes mellitus. Diabetic models have hyperlipidemia.
(F. Wang et al., 2018)	*Perilla frutescens* (L.) Britton	Leave	Lamiaceae	WW	Glucolipid metabolism and gut microbiota are examined in diabetic KKAy mice by supplementing perilla oil.
(Tonelli et al., 2022)	*Bauhinia forficata* Link	Leaf	Leguminosae	Barzil, Argentina	An extract of B forficata leaves was used as an adjuvant in this study in order to improve glycemic control in patients with type-2 diabetes melitus.
(Singh, 2022)	*Ferula assa-foetida* L.	Gum	Apiaceae	Iran, Afghanestan	The docking scores, binding affinities, and 3D structure studies indicate that Kamolonol, Gummosin, Picealactone B, and Farnesiferol A show potential anti-amylase activities, while, Feselol, Conferol, Farnesiferol C, and Epi-conferdione show potential anti-glucosidase activities.
(Pingali, Sukumaran, & Nutalapati, 2020)	*Terminalia chebula Retz.*	Seeds	Combretaceaechebulic	Nepal, Seri Lanka, China	T2D patients treated with 500 mg and 250 mg of T chebula showed endothelial dysfunction and biomarkers of oxidative stress. In patients with T2D, T chebula (especially 500 mg BID dose) drastically ↓ cardiovascular risk factors.
	Allium sativum L.	Bulb	Amaryllidace	WW	A study examined the effects of garlic on anxiety and depression in rats with streptozotocin (STZ)-induced

					diabetes. In diabetic rats, garlic ↓ oxidative stress and anxiety-related behaviors.
(Mail et al., 2021)	*Kaempferia parviflora* Wall. ex Baker	root	Zingiberaceae	Thailand	T2D and healthy people testing Volten VR4®. It has been shown that KP is specific for ↓ blood glucose levels because of flavonoids and polymethoxyflavones. The VR4® capsules drastically ↓ the blood glucose level after fasting or postprandially in diabetics.
(S. Wang, Li, & Shen, 2021)	*Dendrobium chrysotoxum* Lindl.	Aerial parts	orchidaceae	China-South Asia	Through high-throughput sequencing, D officinale's pharmacology was investigated by analyzing its effects on gut microbiota in T2D model mice. Blood sugar levels were drastically ↓ in mice with T2D after taking D officinale supplement. In addition, Dendrobium officinale supplementation has been shown to ↑ relative abundances of bacteria associated with T2D development, such as Akkermansia and Parabacteroides.
(Peter et al., 2019)	*Momordica charantia* L.	Fruit	Cucurbitaceae	Asia	As a result of using M charantia, A1C, 2-h glucose, glucose AUC, weight, BMI, fat percentage, and weight gain, as well as insulin AUC, first phase, and total insulin secretion, were lower
(Geberemeskel, Debebe, & Nguse, 2019)	*Trigonella foenum-graecum* L.	Leave	Fabaceae	India	Using Trigonella foenum-graecum seed powder solution improved lipid metabolism in T2D without any negative side effects, according to the present study. This means Trigonella foenum-graecum seed could provide new options for T2D management.
(Park, Ahn, Kim, & Nam, 2020)	*Panax ginseng* C.A.Mey.	Roots/leaves,	Araliaceae	Asia, America	During 24 weeks of Red Gensing treatment, follistatin levels and SHBG levels improved significantly in diabetes patients, especially old postmenopausal women. There's a need for a larger population study with a longer follow-up period to verify and understand how RG works.

FBG: fasting blood glucose; **FINS** : fasting serum insulin,

5. Processing of Herbal Medicine

Herbal products created from medicinal plants, with or without auxiliaries, in a special formulation (ointments, tablets and decoctions). They are made from either herbal parts (fresh water, dried roots) or herbal medicines (extracts). People use medicinal products to improve or maintain their health. Herbal diabetic treatments are formulated or prescribed according to the patient's main symptoms. The route of administration and forms of herbals are divided into two groups: oral administration and dermal administration, where the herbs take from mouth, and dermal absorption.

The oral administration route is commercial, and most commonly used medication administration route could be different forms such as solid, liquid and gas forms. Solid medicine is like pills, tablets, capsules, and powders. Capsules are principally made from gelatin shells where the medicine can be inserted. Powders are pulverized into various particle sizes, excluding nanopowder. Powders are prepared by grinding or pulverizing dried plant materials to the appropriate particle size. When in use, they are dissolved in warm water, or typically packaged in capsules or bags. Liquid medicine such as herbal tea, decoction, syrup, tincture, etc. Gas form of medicine is another type of oral route is use in herbal medication such steam, smoke and inhalation.

Dermal form is another absorption of herbs to the body. Many herbs are used with a variety of forms to the skin. Essential oil extracts are usually applied to the skin after being diluted in carrier oil. Dermal route can be used in various forms such as ointment, balm, cream, mask, etc. Ointment is the softest tissue and can treat several medicinal issues, such eczema, irritation, rash and itchy skin. Herbal mask are known for their soothing and cleansing properties and help keep skin clean and clear. Another type of dermal is cream, which is used for skin or pin in the body like palm cream, which is used for headaches or backache.

6. Challenges of Promoting AMT

The above studies show that traditional medical treatment was easily available for people with minimum cost. Healers live in the neighborhood and sometimes carry their medication to parks where it is easily accessible. A systematic review of diabetes studies in sub-Saharan Africa reveals challenges to accessing diagnosis and treatment(Hall, Thomsen, Henriksen, & Lohse, 2011). Elizeus et al. research about using herbs to treat diabetes (Rutebemberwa et al., 2013). The study shows that because biomedical diabetes treatment is not available and traditional medicine is easier to obtain, that would be one factor that encourages diabetics to choose traditional medicines instead of or simultaneously with biomedicines. This requires increasing the number of diabetes health centers to reduce the number of diabetic patients in need of treatment.

This section we categories the most common challenges in promoting AMT as follow: Scientists and researchers face many challenges in developing AMT and plant products as anti-DM agents. First, the toxicity of medical plant products and side effects caused by drug interaction among herb cannot be ignored. Secondly, herbs come from natural plants, and as novel materials, their active ingredients are not patentable for scientists. Thirdly Standardization of herbs, it should be accomplished through proper control over the raw materials, the extraction process and the final formulation. Another challenge is Socio-economic barriers. According to the medical organization, the global market for medical plants is estimated at $ 60 billion and is growing steadily, however, there are growing concerns about the availability of medicinal plants as well as their rising cost. Policies of governments in accessing indigenous knowledge.

According to the WHO in 2002, some essential needs such as national policies and regulations for the safety, effectiveness, quality and rational use of medicinal plants have been addressed. Among 213 member of WHO only 66 countries have traditional medication policy, whereas 43 countries have

legislation and 20 member states are establishing regulatory policies (Bodeker, Kronenberg, & Burford, 2007). The most important key factors presented in the national medical plant policies, defining the role of governments in the development of medical plant, providing assurance and quality assurance for treatments and products, rules for TCAM providers, providing education and training, promoting appropriate / rational use, creating capacity building for human resources, including the allocation of financial resources, coverage by public health insurance, and consideration of intellectual property issues. Nevertheless, Most countries, as well as many developed countries, have strict regulations to control the use of traditional medicine, but there is an increasing tendency to use 'health supplements' and spas instead.

In addition, lack of methodical scientific investigation is another term researchers should consider for development of AMT. So far, over 400 herbal therapies have been reported for diabetes, however, only a small number of them were evaluated for scientific and medical reasons. The hypoglycemic effects of some plant extracts have been verified in both human and animal models of type 2 diabetes. The WHO Diabetes Committee recommends that more traditional herbs be studied. Unknown side-effects, consequences, allergies need to investigate. Using herbs not clinically proven beneficial for diabetes patients may delay appropriate treatment, leading to complications and death. Researchers in Canada and Brazil found that patients prefer treatments with lower costs, fewer side effects, and better results. Figure 7 shows the common challenges in developing AMT as anti-DM agents.

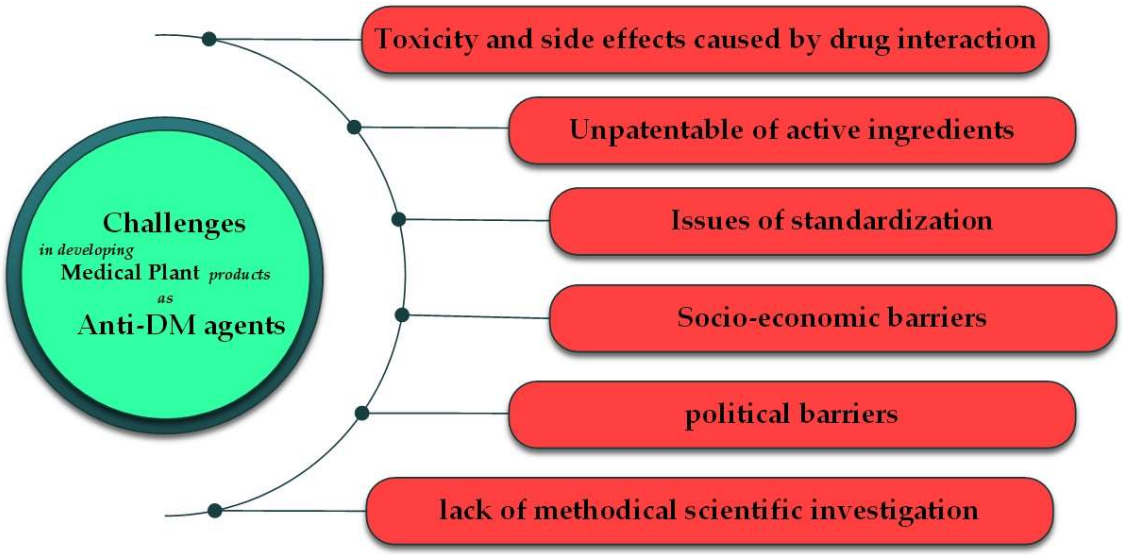

Figure 7. Alternative Medical Treatment Challenges for development

7. Conclusions and Recommendations

A diabetes diagnosis can be defined as a blood sugar level that is too high. Globally, millions of people suffer from this disease. It is still necessary to conduct research on diabetes. Diabetes and insulin deficiency cause sugar to accumulate in the blood rather than reaching the cells and producing energy. As a result of extra sugar being in the blood, blood sugar levels rise, which in turn causes the symptoms of high blood sugar. According to the above literature, nearly 80 percent of the population in developing countries use traditional therapies, most of which are herbal remedies, to meet their basic health care needs. Studies on diabetic patients show that complementary therapies used in these patients include diet and lifestyle, herbal medicines containing antidiabetic agents, magnetic therapy, mind and body exercises, massage therapy, and music therapy. Traditional medicine is used as a source of complementary medicine in modern pharmacy and health products. Scientists and researchers face many challenges in developing AMT and plant products as anti-DM agents and government need to change the policy in order to minimize the challenges. Medicinal plants are of particular importance for pharmacological research and

drug development, both in the direct use of herbal compounds and as leader compounds for drug synthesis. Therefore, arrangements should be made to collect, recognize and evaluate the effect of these native medicinal plants as well as some non-native plants that are available in perfumeries, and the results should be available in the form of conferences, training classes, pamphlets, etc. Patients and patients' families. For future study recommended to conduct on following:

- The analysis of a variety of sociological surveys on various aspects of the public's perceptions of alternate medical treatments for diabetics will help us to gain a deeper understanding of the public opinion.
- Developing a suitable policy framework to be followed in order to improve the development of traditional knowledge as a frontier scientific output while safeguarding the rights of the knowledge holders.
- To improve the outcomes for patients, alternative medical treatments are being integrated with modern medical technologies in order to make them more effective.
- The establishment of scientific knowledge bases is essential in order for research and development to be more productive, as well as for the development of new products.
- To develop the new interface Chatgpt to introduce the potential development for AMT.

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Author contributions

Fatemeh Gheytasi: Conceptualization, Methodology, Software. **Chandima Gomes:** Data curation, Reviewing supervising. **Maryam Moodi:** supervising - Reviewing and Editing. All authors read and approved the final manuscript.

List of Abbreviations

AMT, Alternative Medical Treatment;
WHO, World Health Organization;
WOS, Web of Science;
T2D, Type 2 diabetes;
BMI, Body Mass Index;
TCM, Traditional Chinese medicine;
TCAM, Traditional, complementary and alternative medicine;
G-6-p (ase), Glucose-6-phosphate dehydrogenase;
LDH, lactate dehydrogenase;
LPL, Lipoprotein lipase;
STZ, Streptozotocin;
AT1, Angiotensin II receptor type 1;
DM, diabetes mellitus;
LDL, low-density lipoprotein;
HDL, High-density lipoprotein;

References

Aday, A. W., & Matsushita, K. (2021). Epidemiology of peripheral artery disease and polyvascular disease. *Circulation research, 128*(12), 1818-1832.

Aghili, M., Khorasani, A., & Shirazi, M. (2008). Gharabadin kabir. *Tehran: Research Institute for Islamic and Complementary Medicine*.

Ashraf, R., Khan, R. A., & Ashraf, I. (2011). Garlic (Allium sativum) supplementation with standard antidiabetic agent provides better diabetic control in type 2 diabetes patients. *Pak J Pharm Sci, 24*(4), 565-570.

Ayele, K., Tesfa, B., Abebe, L., Tilahun, T., & Girma, E. (2012). Self care behavior among patients with diabetes in Harari, Eastern Ethiopia: the health belief model perspective. *PloS one, 7*(4), e35515.

Ayenampudi, S. B., Verma, R., & Adeyeye, S. A. O. (2022). The potential health benefits and food applications of jamun (Syzygium cumini L.), an indigenous fruit of India. *Nutrition & Food Science*(ahead-of-print).

Barkat, M. A., Goyal, A., Barkat, H. A., Salauddin, M., Pottoo, F. H., & Anwer, E. T. (2021). Herbal Medicine: Clinical Perspective and Regulatory Status. *Combinatorial Chemistry & High Throughput Screening, 24*(10), 1573-1582.

Basavarajappa, G. M., Nanjundan, P. K., Alabdulsalam, A., Asif, A. H., Shekharappa, H. T., Anwer, M. K., & Nagaraja, S. (2020). Improved Renoprotection in Diabetes with Combination Therapy of Coccinia indica Leaf Extract and Low-Dose Pioglitazone. *Separations, 7*(4), 58.

Bayat, D., Mohammadbeigi, A., Parham, M., Mehrandasht, A., Hashemi, M., Mahlooji, K., & Asghari, M. (2019). The effect of massage on diabetes and its complications: A systematic review. *Crescent J. Med. Biol. Sci, 7*, 22-28.

Beck, R. W., Bergenstal, R. M., Laffel, L. M., & Pickup, J. C. (2019). Advances in technology for management of type 1 diabetes. *The Lancet, 394*(10205), 1265-1273.

Berbudi, A., Rahmadika, N., Tjahjadi, A. I., & Ruslami, R. (2020). Type 2 diabetes and its impact on the immune system. *Current diabetes reviews, 16*(5), 442.

Bhamre, V. Ayurvedic approach in treatment of Diabetes Mellitus.

Bodeker, G., Kronenberg, F., & Burford, G. (2007). Policy and public health perspectives on traditional, complementary and alternative medicine: an overview. *Traditional, complementary and alternative medicine: policy and public health perspectives*, 9-40.

Chakrabarti, S., Biswas, T. K., Seal, T., Rokeya, B., Ali, L., Khan, A. A., . . . Mukherjee, B. (2005). Antidiabetic activity of Caesalpinia bonducella F. in chronic type 2 diabetic model in Long-Evans rats and evaluation of insulin secretagogue property of its fractions on isolated islets. *Journal of ethnopharmacology, 97*(1), 117-122.

Chen, C., Liu, J., Sun, M., Liu, W., Han, J., & Wang, H. (2019). Acupuncture for type 2 diabetes mellitus: a systematic review and meta-analysis of randomized controlled trials. *Complementary therapies in clinical practice, 36*, 100-112.

Chen, T.-Y., Wen, T.-K., Dai, N.-T., & Hsu, S.-h. (2021). Cryogel/hydrogel biomaterials and acupuncture combined to promote diabetic skin wound healing through immunomodulation. *Biomaterials, 269*, 120608.

Chen, W., Luo, Y.-F., & Liu, J.-P. (2011). Topical herbal medicine for treatment of diabetic peripheral neuropathy: a systematic review of randomized controlled trials. *Complementary Medicine Research, 18*(3), 134-145.

Crocker, R. M., Palmer, K. N., Marrero, D. G., & Tan, T.-W. (2021). Patient perspectives on the physical, psycho-social, and financial impacts of diabetic foot ulceration and amputation. *Journal of Diabetes and its Complications, 35*(8), 107960.

Dabaghian, F. H., Kamalinejad, M., Shojaei, A., & Fard, M. A. (2012). Presenting anti-diabetic plants in Iranian traditional medicine. *Journal of Diabetes and Endocrinology, 3*(5), 61-67.

de Assis, B. B., Chaves, E. d. C. L., de Sousa, L., Chianca, T. C. M., Borges, J. B. C., Terra, A. M. S. V., . . . de Oliveira, P. E. (2021). The effects of auricular acupuncture on vascular parameters on the risk factors for diabetic foot: A randomized clinical trial. *Complementary therapies in clinical practice, 44*, 101442.

Dewangan, H. K., Singh, N., Kumar Megh, S., Singh, S., & Lakshmi. (2022). Optimisation and evaluation of Gymnema sylvestre extract loaded polymeric nanoparticles for enhancement of in vivo efficacy and reduction of toxicity. *Journal of microencapsulation, 39*(2), 125-135.

Deyno, S., Eneyew, K., Seyfe, S., Tuyiringire, N., Peter, E. L., Muluye, R. A., . . . Ogwang, P. E. (2019). Efficacy and safety of cinnamon in type 2 diabetes mellitus and pre-diabetes patients: a meta-analysis and meta-regression. *diabetes research and clinical practice, 156*, 107815.

DiMeglio, L. A., Evans-Molina, C., & Oram, R. A. (2018). Type 1 diabetes. *The Lancet, 391*(10138), 2449-2462.

Eidi, A., Eidi, M., & Esmaeili, E. (2006). Antidiabetic effect of garlic (Allium sativum L.) in normal and streptozotocin-induced diabetic rats. *Phytomedicine, 13*(9-10), 624-629. doi:10.1016/j.phymed.2005.09.010

Fattaneh, H. D., Mohammad, K., Asieh, S., & Mehri, A. F. (2012). Presenting anti-diabetic plants in Iranian traditional medicine. *Journal of Diabetes and Endocrinology, 3*(5), 70-76.

Garcia-Vivas, J. M., Galaviz-Hernandez, C., Becerril-Chavez, F., Lozano-Rodriguez, F., Zamorano-Carrillo, A., Lopez-Camarillo, C., & Marchat, L. A. (2014). Acupoint catgut embedding therapy with moxibustion reduces the risk of diabetes in obese women. *Journal of Research in Medical Sciences: The Official Journal of Isfahan University of Medical Sciences, 19*(7), 610.

Geberemeskel, G. A., Debebe, Y. G., & Nguse, N. A. (2019). Antidiabetic effect of fenugreek seed powder solution (Trigonella foenum-graecum L.) on hyperlipidemia in diabetic patients. *Journal of diabetes research, 2019*.

Gordon, A., Buch, Z., Baute, V., & Coeytaux, R. (2019). Use of ayurveda in the treatment of type 2 diabetes mellitus. *Global advances in health and medicine, 8*, 2164956119861094.

Guo, X., Gao, W., Zhang, D., & Li, M. (2022). The molecular mechanism of Radix astragali, Ginseng, Radix puerariae, and Mulberry leaf in the treatment of diabetic cardiomyopathy based on bioinformatics and network pharmacology.

Gurukar, M. S., Mahadevamma, S., & Chilkunda, N. D. (2013). Renoprotective effect of Coccinia indica fruits and leaves in experimentally induced diabetic rats. *J Med Food, 16*(9), 839-846. doi:10.1089/jmf.2012.2689

Haghani, F., Arabnezhad, M.-R., Mohammadi, S., & Ghaffarian-Bahraman, A. (2022). Aloe vera and streptozotocin-induced diabetes mellitus. *Revista Brasileira de Farmacognosia, 32*(2), 174-187.

Hall, V., Thomsen, R. W., Henriksen, O., & Lohse, N. (2011). Diabetes in Sub Saharan Africa 1999-2011: epidemiology and public health implications. A systematic review. *BMC public health, 11*(1), 1-12.

Hasan, S. E. (2021). Medical geology. *Encyclopedia of Geology*, 684.

Holder, K., & Reddy, P. H. (2021). The COVID-19 effect on the immune system and mitochondrial dynamics in diabetes, obesity, and dementia. *The Neuroscientist, 27*(4), 331-339.

Jafri, M., Aslam, M., Javed, K., & Singh, S. (2000). Effect of Punica granatum Linn.(flowers) on blood glucose level in normal and alloxan-induced diabetic rats. *Journal of ethnopharmacology, 70*(3), 309-314.

Jahan, F., Alvi, S. S., & Islam, M. H. (2022). Berberis aristata and its secondary metabolites: insights into nutraceutical and therapeutical applications. *Pharmacological Research-Modern Chinese Medicine*, 100184.

Jain, P., Joshi, A. M., & Mohanty, S. (2021). Everything you wanted to know about noninvasive glucose measurement and control. *arXiv preprint arXiv:2101.08996*.

Jayawardena, R., Ranasinghe, P., Chathuranga, T., Atapattu, P. M., & Misra, A. (2018). The benefits of yoga practice compared to physical exercise in the management of type 2 Diabetes Mellitus: A systematic review and meta-analysis. *Diabetes & Metabolic Syndrome: Clinical Research & Reviews, 12*(5), 795-805.

Kamble, S. M., Kamlakar, P. L., Vaidya, S., & Bambole, V. D. (1998). Influence of Coccinia indica on certain enzymes in glycolytic and lipolytic pathway in human diabetes. *Indian J Med Sci, 52*(4), 143-146.

Kanetkar, P., Singhal, R., & Kamat, M. (2007). Gymnema sylvestre: A Memoir. *J Clin Biochem Nutr, 41*(2), 77-81. doi:10.3164/jcbn.2007010

Koithan, M. (2009). Introducing complementary and alternative therapies. *The Journal for Nurse Practitioners, 5*(1), 18-20.

Laha, S., & Paul, S. (2019). Gymnema sylvestre (Gurmar): A potent herb with anti-diabetic and antioxidant potential. *Pharmacognosy Journal, 11*(2).

Lee, S. (2020). Principle of Saam Five Element Acupuncture.

Li, D., Wang, C., Ruan, D., Li, J., Ji, N., Ma, X., . . . Song, L. (2020). Chinese massage, Tui Na, combined with herbs improves clinical symptoms and regulates sex hormones in patients with mammary gland hyperplasia. *Medicine, 99*(21).

Lian, F., Ni, Q., Shen, Y., Yang, S., Piao, C., Wang, J., . . . Lu, H. (2020). International traditional Chinese medicine guideline for diagnostic and treatment principles of diabetes. *Ann. Palliat. Med, 9*(4), 2237-2250.

Liao, H., Xi, P., Chen, Q., Yi, L., & Zhao, Y. (2007). Clinical study on acupuncture, moxibustion, acupuncture plus moxibustion at Weiwanxiashu (EX-B3) for treatment of diabetes. *Zhongguo Zhen jiu= Chinese Acupuncture & Moxibustion, 27*(7), 482-484.

Lin, X.-x., Xu, X.-y., & Shangguan, B.-b. (2014). Chinese herbal foot bath plus acupoint massage beneficial to the improvement of grade 0 diabetic foot. *Journal of Acupuncture and Tuina Science, 12*(5), 290-294.

Liu, X., Miller, Y. D., Burton, N. W., Chang, J.-H., & Brown, W. J. (2011). Qi-Gong Mind–Body therapy and diabetes control: a randomized controlled trial. *American Journal of Preventive Medicine, 41*(2), 152-158.

Mail, M. A., Nordin, M. N., Ani, I. C., Jemberang, J., Ishak, R., Hasan, A. N., . . . Hamzah, R. (2021). Evaluating the Effect of Volten VR4® Kaempferia parviflora Extracts on Blood Glucose Levels in Human Type-2 Diabetes Mellitus and Healthy Individual: A Case-Control Study. *Journal of the Medical Association of Thailand= Chotmaihet thangphaet*.

Mansour, M. H., Al-Qattan, K., Thomson, M., & Ali, M. (2013). Garlic (Allium sativum) down-regulates the expression of angiotensin II AT(1) receptor in adrenal and renal tissues of streptozotocin-induced diabetic rats. *Inflammopharmacology, 21*(2), 147-159. doi:10.1007/s10787-012-0139-3

Marshall, A. C. (2020). *Traditional Chinese medicine and clinical pharmacology*: Springer.

Mashour, N. H., Lin, G. I., & Frishman, W. H. (1998). Herbal medicine for the treatment of cardiovascular disease: clinical considerations. *Archives of internal Medicine, 158*(20), 2225-2234.

McIntyre, H. D., Catalano, P., Zhang, C., Desoye, G., Mathiesen, E. R., & Damm, P. (2019). Gestational diabetes mellitus. *Nature reviews Disease primers, 5*(1), 1-19.

Mehrzadi, S., Tavakolifar, B., Huseini, H. F., Mosavat, S. H., & Heydari, M. (2018). The effects of Boswellia serrata gum resin on the blood glucose and lipid profile of diabetic patients: A double-blind randomized placebo-controlled clinical trial. *Journal of evidence-based integrative medicine, 23*, 2515690X18772728.

Meng, D., Chunyan, W., Xiaosheng, D., & Xiangren, Y. (2018). The effects of qigong on type 2 diabetes mellitus: a systematic review and meta-analysis. *Evidence-Based Complementary and Alternative Medicine, 2018*.

Micozzi, M. S. (2014). *Fundamentals of complementary and alternative medicine-E-book*: Elsevier Health Sciences.

Mogre, V., Johnson, N. A., Tzelepis, F., & Paul, C. (2019). Barriers to diabetic self-care: A qualitative study of patients' and healthcare providers' perspectives. *Journal of clinical nursing, 28*(11-12), 2296-2308.

Naderi, R., Mohaddes, G., Mohammadi, M., Alihemmati, A., Badalzadeh, R., Ghaznavi, R., . . . Mohammadi, S. (2015). Preventive effects of garlic (Allium sativum) on oxidative stress and histopathology of cardiac tissue in streptozotocin-induced diabetic rats. *Acta Physiol Hung, 102*(4), 380-390. doi:10.1556/036.102.2015.4.5

Orgah, J. O., He, S., Wang, Y., Jiang, M., Wang, Y., Orgah, E. A., . . . Han, J. (2020). Pharmacological potential of the combination of Salvia miltiorrhiza (Danshen) and Carthamus tinctorius

(Honghua) for diabetes mellitus and its cardiovascular complications. *Pharmacological research, 153*, 104654.

Organization, W. H. (2020). Traditional medicine in the WHO South-East Asia Region: review of progress 2014–2019.

Ovesná, J., Mitrová, K., & Kučera, L. (2015). Garlic (A. sativum L.) alliinase gene family polymorphism reflects bolting types and cysteine sulphoxides content. *BMC Genet, 16*, 53. doi:10.1186/s12863-015-0214-z

Ozioma, E.-O. J., & Chinwe, O. A. N. (2019). Herbal medicines in African traditional medicine. *Herbal medicine, 10*, 191-214.

Park, K., Ahn, C. W., Kim, Y., & Nam, J. S. (2020). The effect of Korean Red Ginseng on sarcopenia biomarkers in type 2 diabetes patients. *Archives of Gerontology and Geriatrics, 90*, 104108.

Patel, J. R., Tripathi, P., Sharma, V., Chauhan, N. S., & Dixit, V. K. (2011). Phyllanthus amarus: ethnomedicinal uses, phytochemistry and pharmacology: a review. *Journal of ethnopharmacology, 138*(2), 286-313.

Peter, E. L., Kasali, F. M., Deyno, S., Mtewa, A., Nagendrappa, P. B., Tolo, C. U., . . . Sesaazi, D. (2019). Momordica charantia L. lowers elevated glycaemia in type 2 diabetes mellitus patients: Systematic review and meta-analysis. *Journal of Ethnopharmacology, 231*, 311-324.

Pingali, U., Sukumaran, D., & Nutalapati, C. (2020). Effect of an aqueous extract of Terminalia chebula on endothelial dysfunction, systemic inflammation, and lipid profile in type 2 diabetes mellitus: a randomized double-blind, placebo-controlled clinical study. *Phytotherapy Research, 34*(12), 3226-3235.

Poonam, T., Prakash, G. P., & Kumar, L. V. (2013). Influence of Allium sativum extract on the hypoglycemic activity of glibenclamide: an approach to possible herb-drug interaction. *Drug Metabol Drug Interact, 28*(4), 225-230. doi:10.1515/dmdi-2013-0031

Priya, G., & Kalra, S. (2018). Mind–body interactions and mindfulness meditation in diabetes. *European Endocrinology, 14*(1), 35.

Putiri, A. L., Close, J. R., Lilly, H. R., Guillaume, N., & Sun, G.-C. (2017). Qigong exercises for the management of type 2 diabetes mellitus. *Medicines, 4*(3), 59.

Qazi, N., Khan, R. A., Rizwani, G. H., & Feroz, Z. (2014). Effect of Carthamus tinctorius (Safflower) on fasting blood glucose and insulin levels in alloxan induced diabetic rabbits. *Pak. J. Pharm. Sci, 27*(2), 377-380.

Rajasekaran, S., Sivagnanam, K., & Subramanian, S. (2005). Mineral contents of Aloe vera leaf gel and their role on streptozotocin-induced diabetic rats. *Biological trace element research, 108*, 185-195.

Rao, M. U., Sreenivasulu, M., Chengaiah, B., Reddy, K. J., & Chetty, C. M. (2010). Herbal medicines for diabetes mellitus: a review. *Int J PharmTech Res, 2*(3), 1883-1892.

Raveendran, A. V., Deshpandae, A., & Joshi, S. R. (2018). Therapeutic role of yoga in type 2 diabetes. *Endocrinology and Metabolism, 33*(3), 307-317.

Rezadad, M. I., & Maghami, M. (2014). Quantitative and qualitative analysis on trend of literature on flapping wing (2004–2014) by bibliometric analysis. *International Review of Aerospace Engineering (IREASE), 7*(6).

Rezaei, A., Farzadfard, A., Amirahmadi, A., Alemi, M., & Khademi, M. (2015). Diabetes mellitus and its management with medicinal plants: A perspective based on Iranian research. *Journal of ethnopharmacology, 175*, 567-616.

Rozenberg, K., & Rosenzweig, T. (2018). Sarcopoterium spinosum extract improved insulin sensitivity in mice models of glucose intolerance and diabetes. *PloS one, 13*(5), e0196736.

Rutebemberwa, E., Lubega, M., Katureebe, S. K., Oundo, A., Kiweewa, F., & Mukanga, D. (2013). Use of traditional medicine for the treatment of diabetes in Eastern Uganda: a qualitative exploration of reasons for choice. *BMC international health and human rights, 13*, 1-7.

Saggar, S., Mir, P. A., Kumar, N., Chawla, A., Uppal, J., & Kaur, A. (2022). Traditional and Herbal Medicines: Opportunities and Challenges. *Pharmacognosy Research, 14*(2).

Samanta, S., Chanda, R., & Reddy, A. (2019). Anti-diabetic activity of mango (Mangifera indica): a review. *MOJ Bioequiv Availab, 6*(2), 23-26.

Schuster, K. (2010). *Effect of mindfulness meditation on A1C levels in African American females with Type 2 diabetes.* Adler School of Professional Psychology,

Sehajpal, S., & Verma, N. (2022). A Review on Gymnema sylvestre Pharmacognostical Profile and its Anti-hyperglycemic Activity. *Systematic Reviews in Pharmacy, 13*(9), 876-882.

Shenoy, R. S., Prashanth, K. V. H., & Manonmani, H. K. (2018). In Vitro Antidiabetic Effects of Isolated Triterpene Glycoside Fraction from Gymnema sylvestre. *Evid Based Complement Alternat Med, 2018*, 7154702. doi:10.1155/2018/7154702

Shibib, B. A., Amin, M. A., Hasan, A. K., & Rahman, R. (2012). A creeper, Coccinia indica, has anti-hyperglycaemic and anti-ureogenic effects in diabetic rats. *J Pak Med Assoc, 62*(11), 1145-1148.

Siddique, Z., Shad, N., Shah, G. M., Naeem, A., Yali, L., Hasnain, M., . . . Khan, I. (2021). Exploration of ethnomedicinal plants and their practices in human and livestock healthcare in Haripur District, Khyber Pakhtunkhwa, Pakistan. *Journal of ethnobiology and ethnomedicine, 17*(1), 1-22.

Singh, G. (2022). Insilico screening and pharmacokinetic properties of phytoconstituents from Ferula asafoetida H. Karst.(Heeng) as potential inhibitors of α-amylase and α-glucosidase for Type 2 Diabetes Mellitus. *Journal of Diabetes & Metabolic Disorders, 21*(2), 1339-1347.

Syahri, A., Fariha, U., Afandi, R., & Nurliyana, I. (2024). Comparison of logistic regression, random forest and Adaboost algorithms for diabetes mellitus classification. *IJATIS: Indonesian Journal of Applied Technology and Innovation Science, 1*(1), 41-46.

Tan, Y., Hu, J., Pang, B., Du, L., Yang, Y., Pang, Q., . . . Ni, Q. (2020). Moxibustion for the treatment of diabetic peripheral neuropathy: A systematic review and meta-analysis following PRISMA guidelines. *Medicine, 99*(39).

Tian, L.-Y., Bai, X., Chen, X.-H., Fang, J.-B., Liu, S.-H., & Chen, J.-C. (2010). Anti-diabetic effect of methylswertianin and bellidifolin from Swertia punicea Hemsl. and its potential mechanism. *Phytomedicine, 17*(7), 533-539.

Tiwari, P., Mishra, B. N., & Sangwan, N. S. (2014). Phytochemical and pharmacological properties of Gymnema sylvestre: an important medicinal plant. *Biomed Res Int, 2014*, 830285. doi:10.1155/2014/830285

Tom-Orme, L. (1994). Traditional beliefs and attitudes about diabetes among Navajos and Utes. *Joe JR, Young RS, eitords. Diabetes as a Disease of Civilization: Impact of Culture in Indigenous People. New York: Mouton de Gruyter*, 271-291.

Tonelli, C. A., de Oliveira, S. Q., da Silva Vieira, A. A., Biavatti, M. W., Ritter, C., Reginatto, F. H., . . . Dal-Pizzol, F. (2022). Clinical efficacy of capsules containing standardized extract of Bauhinia forficata Link (pata-de-vaca) as adjuvant treatment in type 2 diabetes patients: A randomized, double blind clinical trial. *Journal of Ethnopharmacology, 282*, 114616.

Umaru, I. J., Umaru, H. A., & Umaru, K. I. (2019). Potential of Barringtonia Racemosa (L.) Dichloromethane extract on Streptozotocin (STZ)-induced type 2 diabetic rats. *Current Research in Diabetes & Obesity Journal, 9*(4), 99-106.

Unnikrishnan, R., & Misra, A. (2021). Diabetes and COVID19: a bidirectional relationship. *Nutrition & Diabetes, 11*(1), 1-5.

Unschuld, P. U. (2019). Traditional Chinese medicine. In *Traditional Chinese Medicine*: Columbia University Press.

Uuh Narvaez, J. J., & Segura Campos, M. R. (2022). Combination therapy of bioactive compounds with acarbose: A proposal to control hyperglycemia in type 2 diabetes. *Journal of Food Biochemistry*, e14268.

van Son, J., Nyklíček, I., Nefs, G., Speight, J., Pop, V. J., & Pouwer, F. (2015). The association between mindfulness and emotional distress in adults with diabetes: Could mindfulness serve as a buffer? Results from Diabetes MILES: The Netherlands. *Journal of Behavioral Medicine, 38*(2), 251-260.

Verma, S., Gupta, M., Popli, H., & Aggarwal, G. (2018). Diabetes mellitus treatment using herbal drugs. *International Journal of Phytomedicine, 10*(1), 1-10.

Wadood, A., Wadood, N., & Shah, S. (1989). Effects of Acacia arabica and Caralluma edulis on blood glucose levels of normal and alloxan diabetic rabbits. *J Pak Med Assoc, 39*(8), 208-212.

Wang, F., Zhu, H., Hu, M., Wang, J., Xia, H., Yang, X., . . . Sun, G. (2018). Perilla oil supplementation improves hypertriglyceridemia and gut dysbiosis in diabetic KKAy mice. *Molecular nutrition & food research, 62*(24), 1800299.

Wang, S., Li, X.-Y., & Shen, L. (2021). Modulation effects of Dendrobium officinale on gut microbiota of type 2 diabetes model mice. *FEMS Microbiology Letters, 368*(5), fnab020.

Wang, Z., Wang, J., & Chan, P. (2013). Treating type 2 diabetes mellitus with traditional Chinese and Indian medicinal herbs. *Evidence-Based Complementary and Alternative Medicine, 2013*.

Watkins, Y. J., Quinn, L. T., Ruggiero, L., Quinn, M. T., & Choi, Y.-K. (2013). Spiritual and religious beliefs and practices and social support's relationship to diabetes self-care activities in African Americans. *The Diabetes Educator, 39*(2), 231-239.

Wazir, J., Ullah, R., Li, S., Hossain, M. A., Diallo, M. T., Khan, F. U., . . . Zhou, X. (2019). Efficacy of acupuncture in the treatment of chronic prostatitis-chronic pelvic pain syndrome: a review of the literature. *International Urology and Nephrology, 51*(12), 2093-2106.

West, K. M. (1973). Diet therapy of diabetes: an analysis of failure. *Annals of internal medicine, 79*(3), 425-434.

Widhiantara, I. G., Arunngam, P., & Siswanto, F. M. (2018). Ethanolic extract of Caesalpinia bonducella f. seed ameliorates diabetes phenotype of streptozotocin-nicotinamide-induced type 2 diabetes rat. *Biomedical and Pharmacology Journal, 11*(2), 1127-1133.

Wilson, A., Pandya, D., Mankad, A., & Solanki, H. (2019). A Review on Allium sativum (L.) as medicinal plant.

Wu, F.-L., Tai, H.-C., & Sun, J.-C. (2019). Self-management experience of middle-aged and older adults with type 2 diabetes: A qualitative study. *Asian nursing research, 13*(3), 209-215.

Xiao, E., & Luo, L. (2018). Alternative therapies for diabetes: a comparison of western and traditional Chinese medicine (TCM) approaches. *Current diabetes reviews, 14*(6), 487-496.

Yaghoubi, E., Yaghoubi, E., Maghami, M. R., & Jahromi, M. Z. (2025). Comprehensive technical risk indices and advanced methodologies for power system risk management. *Electric Power Systems Research, 244*, 111534.

Yang, Z., Wang, D., Li, Y., Zhou, X., Liu, T., Shi, C., . . . Zhu, X. (2022). Untargeted metabolomics analysis of the anti-diabetic effect of Red ginseng extract in Type 2 diabetes Mellitus rats based on UHPLC-MS/MS. *Biomedicine & Pharmacotherapy, 146*, 112495.

Yeung, A., Chan, J. S., Cheung, J. C., & Zou, L. (2018). Qigong and Tai-Chi for mood regulation. *Focus, 16*(1), 40-47.

Yuan, L. J., Shanmugam, K., Ren, T. C., Nian, C. n. K., & Shuhili, J. A. M. (2024). Machine Learning Approach in Medical Diagnosis: Predicting Diabetes Complications. *Journal of Applied Technology and Innovation (e-ISSN: 2600-7304), 8*(3), 52.

Zhang, C., & Ye, Y. (2010). Clinical effects of acupuncture for diabetic peripheral neuropathy. *Journal of traditional Chinese medicine, 30*(1), 13-14.

Zhu, J., Chen, H., Song, Z., Wang, X., & Sun, Z. (2018). Effects of ginger (Zingiber officinale Roscoe) on type 2 diabetes mellitus and components of the metabolic syndrome: A systematic review and meta-analysis of randomized controlled trials. *Evidence-based complementary and alternative medicine, 2018*.