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Alternative Medical Treatments for Managing Diabetes: An Overview and Artificial Intelligent Solutions

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Abstract

Alternative medical treatments (AMT) have been used as a source of medicine for thousands of years. One chronic disease that causes high blood sugar levels and metabolic disorders is diabetes, resulting from 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 have led us to consider alternative therapies using herbs to treat diabetes. This review paper aims to introduce and review the application of Artificial Intelligence (AI) to identify and improve the effectiveness of AMT for diabetes from a herbal perspective. Firstly, we discuss the challenges of promoting AMT, common AMT approaches, insulin plant, and the processing of herbal medicine. It has been found that medicinal plants are a priority due to their low cost and accessibility, which is much less than chemical drugs. However, the findings show that there are barriers to developing alternative medical treatments worldwide, such as the lack of scientific investigation, political barriers, side effects, and socioeconomic barriers. The present study demonstrates that although some traditional therapies have been tested and approved in modern scientific studies, further research is required to prove the effectiveness and safety of these drugs by integrating AI. Therefore, greater attention must be paid to use of AI, complementary methods, and university education to expand the production of medicines and natural products.

Keywords: *Diabetes Treatment; Herbal Remedies; Alternative Medical Treatment; Artificial Intelligent*.

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 et al., 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 et al., 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).

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 et al., 2018). 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. 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 et al., 2011). In study (Rutebemberwa et al., 2013) discuss about using herbs to treat diabetes. 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 et al., 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 1 shows the common challenges in developing AMT as anti-DM agents.

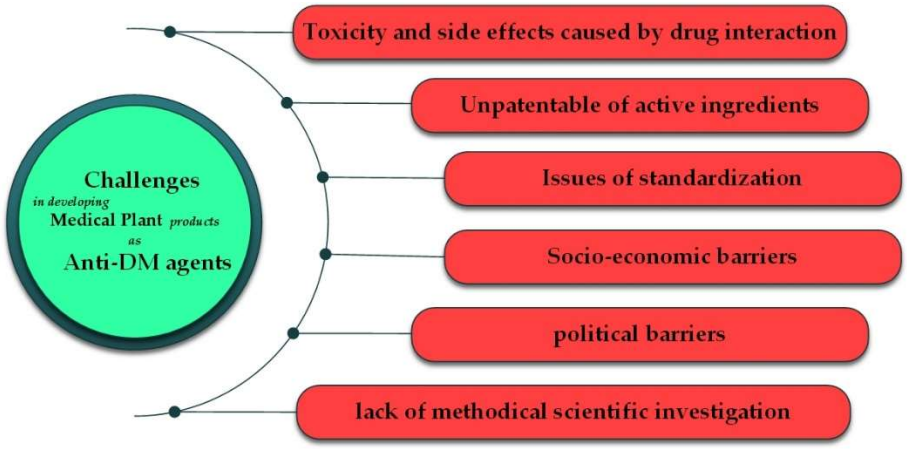

Figure 7. Alternative Medical Treatment Challenges for development

AMT and Artificial Intelligent Solutions

Artificial intelligence (AI) is a rapidly developing field with the potential to revolutionize many aspects of our lives, including healthcare(Yuan et al., 2024). In the field of alternative medical treatment, AI has the potential to improve diagnosis, personalize treatment plans, monitor patients' progress, and increase access to care(Attaluri et al., 2020). For example, AI can be used to analyze large datasets of patient data with different type of diabetics to identify patterns and correlations that may indicate a particular condition. This can be especially helpful for conditions that are difficult to diagnose with traditional methods. AI can also be used to develop personalized treatment plans for patients. This is done by taking into account the patient's individual symptoms, medical history, and preferences. This can help to ensure that patients receive the most effective treatment for their specific condition. In addition, AI can be used to monitor patients' progress over time. This can help to ensure that patients are responding to treatment and that any changes in their condition are detected early.

AI can also be used to deliver alternative medical treatment remotely, making it easier for people to access care, especially those who live in rural areas or who have difficulty traveling. Figure 2 shows that AI can used on different ways to promote AMT in society. In plant area had been many researchers used AI for safety, speed Breeding, forecasting, monitoring, and etc. I the AMT approach AI can be use for training, monitoring the patient, scheduling, best point to apply. In the Patient area, doctor able to monitor the patient, controlling the diet, teaching, training the life style and etc.

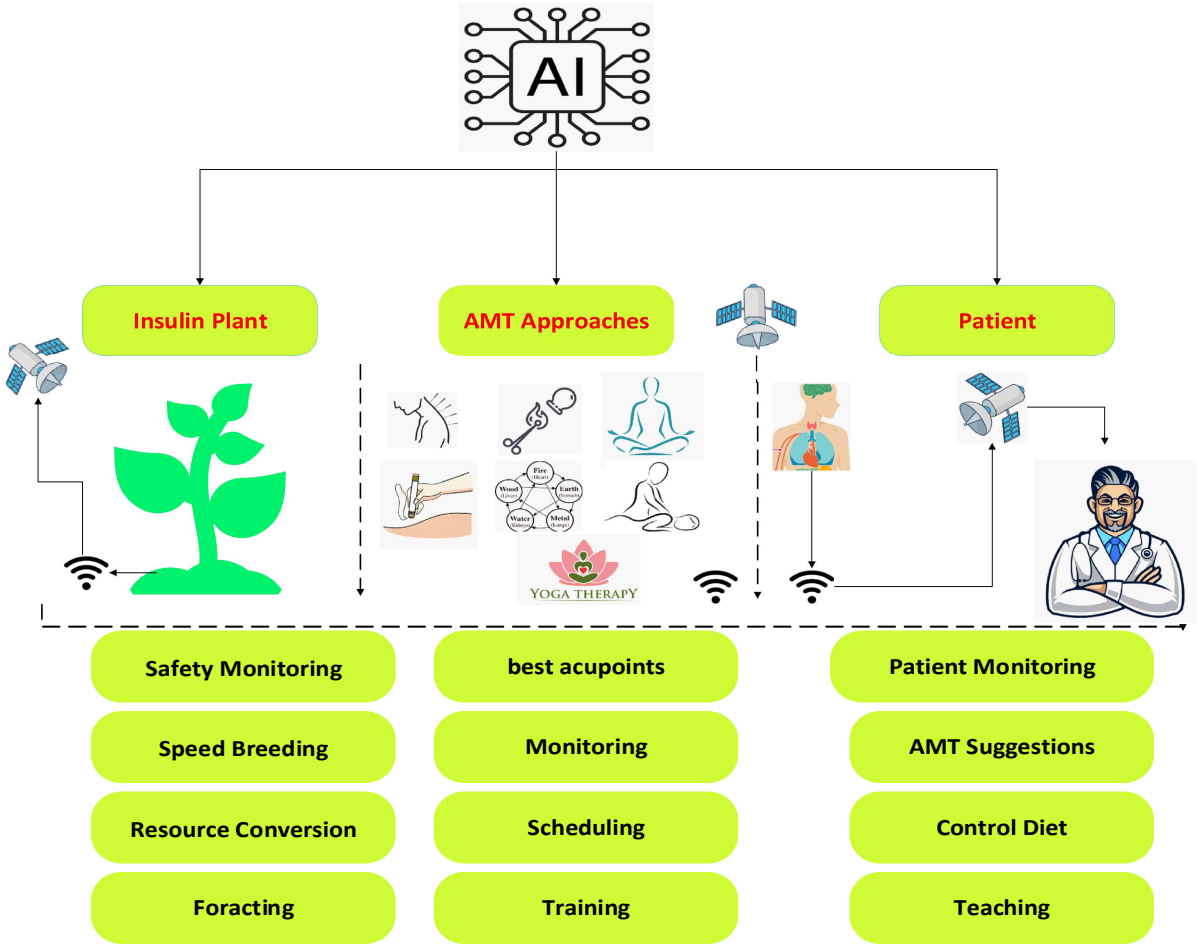

Figure 2: AI potential area in promoting AMT

As AI technology continues to develop, we can expect to see even more innovative applications of AI in alternative medical treatment in treatment of diabetic . For example, AI could be used to develop new alternative medical treatments, to create more realistic virtual reality simulations of alternative medical treatments, and to improve the training of alternative medical practitioners. The use of AI in alternative medical treatment is still in its early stages, but it has the potential to revolutionize the way that these treatments are delivered. AI can help to make alternative medical treatment more effective, efficient, and accessible to a wider range of people. This is an exciting time for the field of alternative medical treatment, and it will be interesting to see how AI continues to shape the future of this field. It is important to note that AI is not a replacement for traditional medical care. AI can be a valuable tool for improving the diagnosis, treatment, and monitoring of conditions, but it should not be used in isolation. Patients should always consult

with a qualified healthcare provider before starting any new treatment, including alternative medical treatments. Table 2 shows there area of the study in academic document and mostly AI was be used to:

Table 2: Diabetics type and AI technique and expected results

Aim	Method	Technique	Process	Expected Result	Potential in Diabetics
Diagnosis	Identify patterns and correlations in patient data that may indicate diabetes.	ML, Monitoring	AI algorithms are trained on a dataset of patient data, including symptoms, medical history, and lab results. The algorithms then learn to identify patterns and correlations in the data that may indicate diabetes.	AI can help to diagnose diabetes more accurately and efficiently.	AI can help to diagnose diabetes earlier, which can lead to better management of the condition.
Personalization	Develop personalized treatment plans for individual patients with diabetes.	ML, Fuzzy,NLP	AI algorithms are trained on a dataset of patient data, including symptoms, medical history, and preferences. The algorithms then learn to recommend specific treatments or dosages based on the patient's individual needs.	AI can help to ensure that patients with diabetes receive the most effective treatment for their individual needs.	AI can help patients with diabetes to find the treatment plan that works best for them.
Monitoring	Monitor patients' progress over time and adjust the treatment plan as needed.	ML, NLP	AI algorithms are used to track patients' progress over time. The algorithms monitor the patient's symptoms, treatment adherence, and overall well-being. The algorithms then adjust the treatment plan as needed to ensure that the patient is receiving the most effective treatment.	AI can help to ensure that patients with diabetes are receiving the most effective treatment and that their condition is being managed effectively.	AI can help patients with diabetes to stay on track with their treatment and to manage their condition effectively.
Development	Develop new AMT for diabetes.	ML, NLP, computer-aided design	AI algorithms are used to analyze the chemical composition of plants to identify potential new active ingredients. AI algorithms are also used to screen potential new AMT for safety and efficacy.	AI can help to develop new, more effective AMT for diabetes.	AI can help to develop new AMT that are more effective and have fewer side effects than traditional treatments.

3. AI and AMT Trends

The use of artificial intelligence (AI) in alternative medical treatment is a growing trend. AI has the potential to improve the effectiveness, efficiency, and accessibility of alternative medical treatments in a number of ways. The number of publications collected from the Web of science repository shows that a total of 10254 papers published between these years. The following graph shows the number of publication base on categories. The number of publications is based on area categories, including plant side, AMT approaches such as accoucheurs, yoga, meditation, etc and patient. From the figure, it is clear that researchers are using AI more in plant side and in patient's side. Based on the funding, the number of publications on using AI in patients' side is around 5136 papers, followed by around 3648 for plant side. It is observed that after 2020 their significant increase in both plant and patients' area due to covid 19 and government policy to more attention on AI. On the other hand, the number of publications on AMT approaches compare bother other 2 area is more less and need to more attention on it. Though there is grow between years 2020 till now but still need more research to promote the AMT. However, number of citation also shows that after 2020, number of citation increased significantly 3fold. 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.

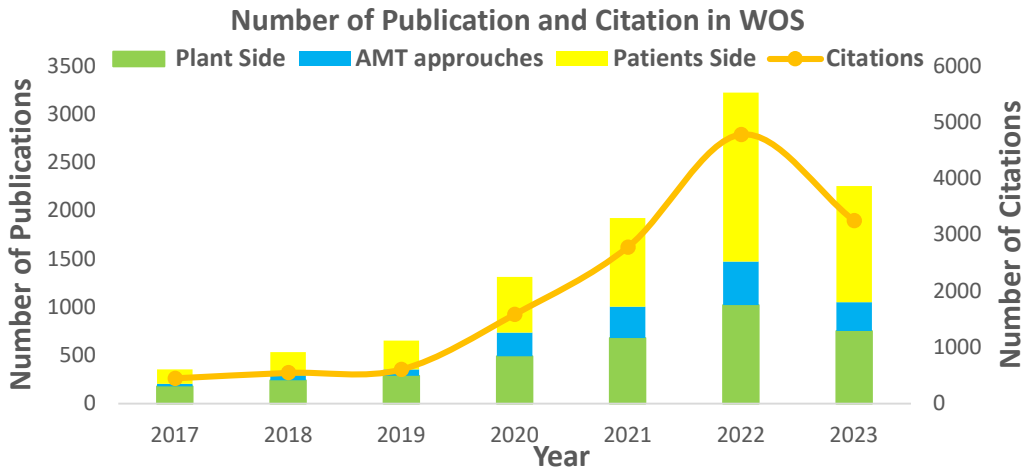

Figure 1. Number of Publication in field of AI and Medicine Treatment in Web of Science

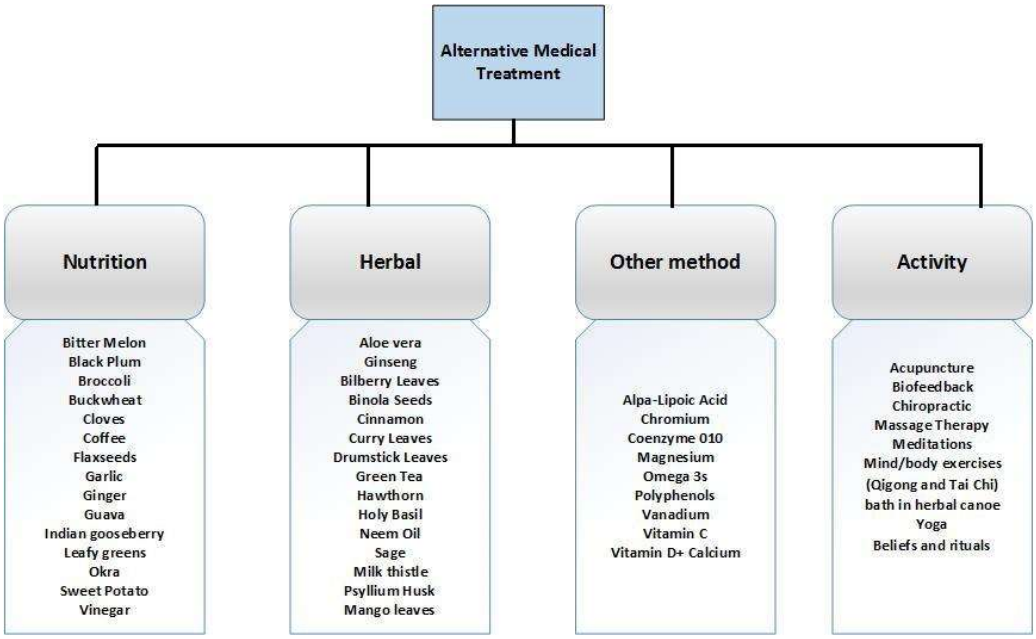

Figure 2. Alternative Medicine Treatment areas categories based on Web of Science (WOS)

4. Overview of Diabetes in Academic Documents

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 found in the blood and is a major energy source 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.

Table 1. Comparison different type of diabetes

Type	No-Papers	Cause	Symptom	Consequence	Treatment	AI Solutions
Type1 (Beck et al., 2019; DiMeglio et al., 2018)	480	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	Digenetic through patterns, Monitor the insulin level.
Type 2 (Berbudi et al., 2020; Uuh Narvaez & Segura Campos, 2022)	1240	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	Tracking, the insulin level, recommend diet, body monitory, sending data to the Doctor.
Pregnant(McIntyre et al., 2019)	108	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	Recommend diet, monitoring, drug level determine to eat.

5. 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 requires 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 et al., 2019).

Reports from the WHO show that one-third of the world's population has almost no access to modern and essential medicines. Nearly half the people in Africa, Asia, and Latin America are 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 they prefer to use AMT if they don't have enough money. 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 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.

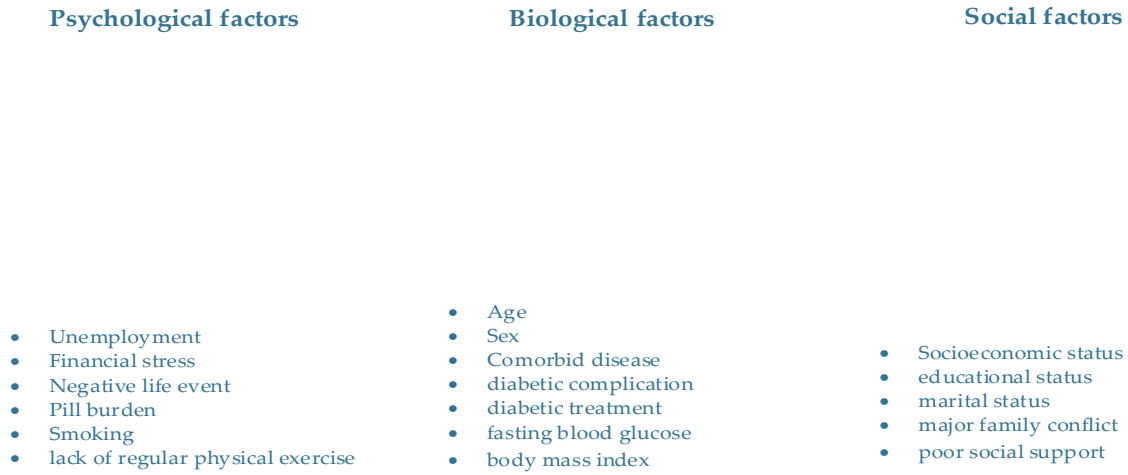

Figure4. Socio-psychic Reasons for Following AMT

6. 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.

A company called Pear is using AI to develop a software program that can help practitioners of Traditional Chinese Medicine (TCM) diagnose conditions. The program analyzes patient data, such as symptoms, medical history, and lab results, to help identify patterns and correlations that may indicate a particular TCM

diagnosis. A team of researchers at Stanford University are using AI to develop a virtual reality simulation of acupuncture. The simulation allows users to experience the sensations of acupuncture without actually receiving needles. This could be used to train acupuncture practitioners or to help patients prepare for acupuncture treatment. **A company called Heal is using AI to develop a mobile app that can help patients track their progress during acupuncture treatment. The app allows patients to record their symptoms, their treatment experiences, and their overall well-being. This information can then be used to adjust the treatment plan as needed.

6.1 Acupuncture

Artificial intelligence (AI) is being used in acupuncture in a number of ways, including: Objectification and standardization of acupuncture, This treatment involves inserting very thin needles deep into the skin at specific points in the body in order to induce healing (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. (2017) purpose is to observe acupuncture's clinical effects 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 et al., 2007). Tsai et al (Chen et al., 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.

6.2 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 (Unschuld, 2019). Indirect moxibustion involves heating the skin with moxa cigars that are held. Or, moxa cigars are put on acupuncture needles to provide heat. 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, significantly improving their sleep quality. Moxibustion has a positive correlation with its therapeutic effect and its therapeutic effect is enhanced by moxibustion time. In study , AI to develop a system that can personalize moxibustion treatments for individual patients. The system takes into account the patient's age, sex, medical history, and other factors to recommend the best acupoints and treatment parameters. A team of researchers at the University of Michigan developed a moxibustion device that uses AI to monitor the effectiveness of the treatment. The device tracks patient symptoms and progress, and this information is used to adjust the treatment as needed.

6.3 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. Qi Gong refers to the connection between the body and mind (Yeung et al., 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 et al., 2017) Diabetes can be managed with specific Qigong exercises. Meng et al (Meng et al., 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. AI can be used in mind/body exercises (Qigong and Tai Chi) in a number of ways, including Personalizing exercises, monitoring progress, Providing feedback, Creating virtual instructors. using AI to research the effects of mind/body exercises on mental health. The researchers are using AI to analyze large datasets of patient records and clinical trials to identify the benefits of mind/body exercises for a variety of mental health conditions.

6.4 Massage with oil treatment

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. Massage with oil is a key component of Ayurvedic treatments(Gordon et al., 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).

6.5 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.

6.6 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 et al., 2018; Raveendran et al., 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 type 2 diabetes. In their review, they summarize evidence from numerous clinical studies regarding the role of yoga practices in diabetes management.

6.7 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 et al., 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(Chen et al., 2011).

6.8 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 the immune system and immune system function (van Son et al., 2015).

Table 2 : Overview Medical plant approaches for treatment of Diabetics

Ref	AMT	Method	Findings	AI and potential
(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	Digenesis the point need to apply Tracking the patient Make pattern recognitions for different type of diabetics
(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.	Real-time monitoring Improved accuracy and efficiency. adherence of moxibustion treatment
(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	indicate which foods are most beneficial for diabetics. AI can also be used to develop personalized diet plans for individual patients, taking into account their individual needs and preferences.
(Liu et al., 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;	analyze a patient's medical history and fitness level to determine which yoga poses are appropriate for them.

(Bayat et al., 2019)	Chinese massage Indian massage Swedish massage; Connective tissue 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)	AI has the potential to revolutionize the way that massage is used to treat diabetics. AI can be used to improve the accuracy, efficiency, personalization, and adherence of massage treatment.
(Wu et al., 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.	AI has the potential to revolutionize the way that medicinal baths are delivered to diabetics, making them more personalized, effective, and accessible.
(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.	analyze a patient's medical history and fitness level to determine which yoga poses are appropriate for them.
(Watkins et al., 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.	AI can be used to improve the accuracy, efficiency, personalization, and adherence of beliefs and rituals practice. This can lead to better outcomes for patients with diabetes.

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;

7. Common Insulin Plant used in AMT and AI integrations.

The combination of herbal medicine and AI solutions has the potential to improve the quality and efficacy of herbal remedies for the management of diabetes, while also ensuring their safety for patients. There are several plants that have been traditionally used as alternative medical treatments for diabetes. 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. AI can integrate with herbal plant processing and production in several ways. One way is through the use of machine learning algorithms to optimize the growing conditions for herbal plants. These algorithms can analyze data on factors such as soil quality, weather patterns, and pest control measures to determine the optimal conditions for growing specific herbs. This can help increase the yield and quality of the herbs while reducing the use of fertilizers and pesticides.

An study in (Dewangan et al., 2022) describes the study of *Gymnema sylvestre* (Retz.) R.Br. ex Sm. that is 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. Machine learning able to determined which part of plant more valuable for medical proposed. In the past the researchers found that 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 et al., 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 et al., 2007). Several studies have shown that G. sylvestre stimulates the pancreas, resulting in an increase in insulin production (Shenoy et al., 2018) but most of them work in traditional ways. Integration of AI can revolutionize this area. AI solutions can be used to optimize the drying and grinding processes to ensure that the maximum amount of active compounds is extracted from the herb. In this study, AI can help with machine learning to optimize the extraction process.

In another study, which is valuable work, 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 et al., 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(which can be diagnosed with machine learning solutions for different animals). According to several studies on diabetic rats, C indica leaf extract contains antiureogenic, antihyperglycemic, antioxidant, hypoglycemic, and hypolipidemic effects (Shibib et al., 2012). Machine learning can help determine the extract material and percentage and how it can be managed. According to (Kamble et al., 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. This activity is believed to be caused by the high levels of phenolics and flavonoids in the fruit. AI is able not only to show how high levels of phenolics and flavonoids can be achieved, but also to recommend which AMT approach and how integration with other components can increase the impact on diabetes, which with traditional methods is difficult and costly.

Another plant which is used in India is *Allium sativum* L. (garlic) and contains non-protein sulfur amino acids with medicinal properties which AI can support the study of garlic by identifying the specific properties and compounds responsible for its medicinal effects. 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 et al., 2019). A sativum extract and glibenclamide improved hypoglycemic effect in streptozotocin-induced diabetic rats (Ovesná et al., 2015; Poonam et al., 2013). Researchers found that there was an improvement in glycemic control and antihyperlipidemic effects with combined metformin and garlic supplementation in diabetics patients (Ashraf et al., 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 et al., 2013) . The effectiveness of garlic extract in controlling diabetes has been shown to be greater than that of glibenclamide (Eidi et al., 2006). Machine learning algorithms can analyze data on the chemical composition of garlic and its effects on various diseases to determine the optimal dosage and formulation for maximum therapeutic benefit. In addition, AI can help optimize the extraction and processing methods to ensure that the maximum amount of active compounds is obtained from the herb. This can help increase the potency and efficacy of garlic-based remedies. Furthermore, AI can assist in the identification of potential interactions between garlic and other medications, and in the prediction of potential side effects or adverse reactions. This can help ensure the safety and efficacy of using garlic in combination with other treatments.

AI able to support Rehmannia glutinosa which similarly to the above approach discuss. Gua et al (Guo et al., 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. AI can assist in the identification of potential interactions between Rehmannia glutinosa and other medications, and in the prediction of potential side effects or adverse reactions. This can help ensure the safe use of Rehmannia glutinosa in combination with other treatments.

Other Medical Herbs

The Indian tribal population uses Guilandina bonduc L. 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 popular in India. This plant is an anti-diabetic in traditional medicine (Samanta et al., 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 et al., 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 et al., 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 et al., 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 et al., 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 et al., 2005). Different parts can be used to extract anti-diabetic properties from various medical plants around the world, as seen in Figure 6 more than 50 herbs listed.

AI in Medical Plant

Figure 5 shows some key ways in which AI can be applied. In *Precision Agriculture*, AI can be used to optimize agricultural practices by analyzing data from sensors, drones, and satellite imagery. It can provide insights into soil health, crop conditions, and weather patterns, allowing farmers to make data-driven decisions about irrigation, fertilization, and pest control. This helps improve crop yield and resource efficiency. In another way, AI can be used for predictive maintenance. By analyzing data from sensors and machinery, AI algorithms can predict when equipment is likely to fail. This enables maintenance teams to schedule repairs before breakdowns occur, reducing downtime and minimizing production losses. In addition, AI can optimize plant processes by analyzing vast amounts of data and identifying patterns that humans might miss. It can optimize production schedules, energy consumption, and resource allocation to improve efficiency and reduce waste. It also enhance quality control by inspecting products using computer vision. It can detect defects, inconsistencies, and deviations from standards much faster and with higher accuracy than manual inspections. In *Supply Chain Management,* AI can analyze supply chain data to optimize inventory levels, forecast demand, and improve logistics. This ensures that the right materials are available at the right time, minimizing inventory costs and production delays. In *Resource Conservation***,** AI can help in conserving resources like water by monitoring and controlling irrigation systems more efficiently, reducing water wastage. In *Plant Health Monitoring,* the health of plants in real-time by analyzing sensor data, identifying diseases or nutrient deficiencies early, and suggesting appropriate actions to maintain plant health. It can be used to enhance plant safety by analyzing data from cameras and sensors to detect potential hazards and ensure compliance with safety protocols.

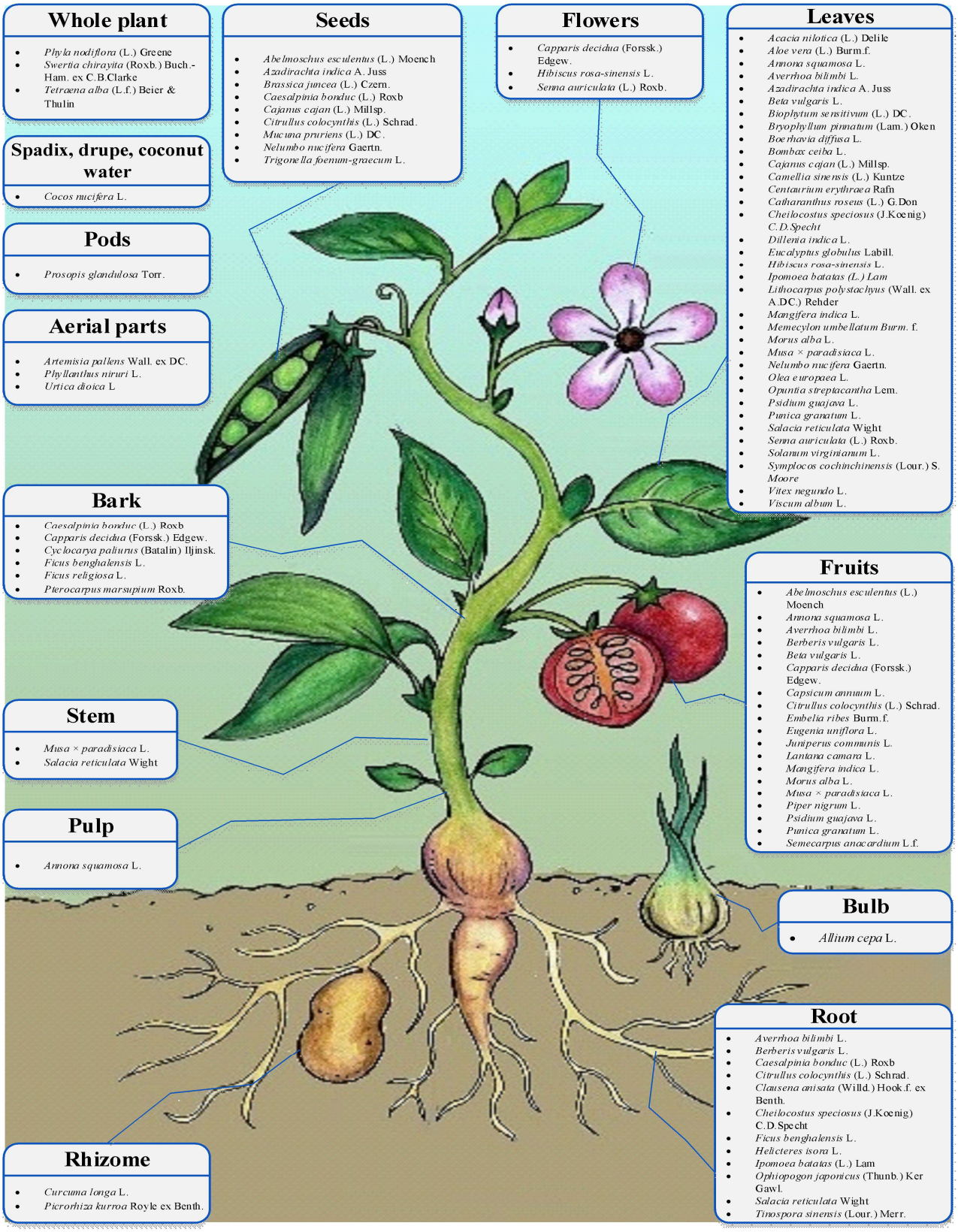

Figure 6. Medical Plant part use for treatment of diabetes

Table 3 Most common herbal medicine for treatment of diabetics

Ref	Name	Part Plant	Family	Location	Aim and objective/ findings
(Rao et al., 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 et al., 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 et al., 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 et al., 2018)	*Zingiber zerumbet* (L.) Roscoe ex Sm.	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.
(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 et al., 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.
(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 et al., 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.

(Wang et al., 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 et al., 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 et al., 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,

8. Processing of Herbal Medicine and AI soultions

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 used, they are dissolved in warm water or packaged in capsules or bags. Liquid medicine such as herbal tea, decoction, syrup, tincture, etc. Gas is another type of oral route used in herbal medication such as 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. AI can revolutionize the processing of herbal medicine by offering advanced data analytics and machine learning algorithms. Through AI-driven research, herbal products can be formulated with improved precision, taking into account the intricate interactions between medicinal plants and auxiliaries. Additionally, AI can analyze vast databases of medical literature and clinical trials, aiding in the identification of optimal herbal combinations for specific health conditions, ultimately enhancing the efficacy of herbal treatments.

9. Conclusions and Future Study 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. In order to further develop and improve the use of alternative medical treatments for diabetes, it is recommended that researchers integrate AI techniques into their studies. AI can help analyze large amounts of data on patient outcomes and treatment efficacy, identify patterns, and personalize treatment plans based on individual patient characteristics. By using AI to identify and evaluate the effect of native medicinal plants and other alternative treatments, researchers can gain a better understanding of their potential as anti-DM agents. Additionally, policymakers should consider changing policies to minimize the challenges that researchers face in developing AMT and plant products. By combining the knowledge gained from traditional medicine with the power of AI, we can work towards

developing safer and more effective treatments for diabetes and other chronic diseases. For future study recommended to conduct on following:

- Conduct more research on the use of AI in identifying and evaluating the effectiveness of traditional herbal remedies for diabetes.
- Investigate the potential of using AI to analyze large-scale data on patient outcomes and treatment efficacy for alternative medical treatments for diabetes.
- Explore the use of AI to personalize treatment plans based on individual patient characteristics and medical histories.
- Conduct more studies on the safety and effectiveness of complementary therapies, such as diet and lifestyle changes, magnetic therapy, mind and body exercises, massage therapy, and music therapy, using AI to analyze patient outcomes.
- Investigate the potential of combining AI with other emerging technologies, such as blockchain, to improve the safety and transparency of herbal medicine supply chains.
- Conduct more studies on the socioeconomic barriers to accessing alternative medical treatments for diabetes and explore how AI can be used to address these barriers.
- Investigate the use of AI to identify potential interactions and contraindications between alternative medical treatments and pharmaceutical medications used to treat diabetes.
- Conduct research on the potential of AI to develop new anti-DM agents based on the chemical compounds found in traditional herbal remedies.
- Investigate the use of AI to optimize the processing and extraction of active compounds from medicinal plants for use in alternative medical treatments for diabetes.
- Finally, explore the potential of using AI to develop new predictive models for identifying individuals at risk of developing diabetes and determining the most effective preventative measures.

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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;
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;

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.

Attaluri, S. S., Batcha, N. K., & Mafas, R. (2020). Crop plantation recommendation using feature extraction and machine learning techniques. *Journal of Applied Technology and innovation*, *4*(4), 1-4.

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., Nahar, N., Mosihuzzaman, M., & 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., Brasileiro, T. O. Z., Costa, M. F., Pereira, F. C., & 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., Tolo, C. U., & 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. https://doi.org/10.1016/j.phymed.2005.09.010

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. https://doi.org/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.

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.

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. https://doi.org/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., Li, Y., Qu, Y., Xuan, Z., & 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).

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., Ahmad, M. I., Omar, M. R., & 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. https://doi.org/10.1007/s10787-012-0139-3

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

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.

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., Ghyasi, 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. https://doi.org/10.1556/036.102.2015.4.5

Orgah, J. O., He, S., Wang, Y., Jiang, M., Wang, Y., Orgah, E. A., Duan, Y., Zhao, B., Zhang, B., & 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.

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. https://doi.org/10.1186/s12863-015-0214-z

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., Ogwang, P. E., & 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. https://doi.org/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.

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. https://doi.org/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., Mahmood, A., Sajid, M., Idrees, 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.

Tan, Y., Hu, J., Pang, B., Du, L., Yang, Y., Pang, Q., Zhang, M., Wu, Q., Zhang, Y., & 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. https://doi.org/10.1155/2014/830285

Tonelli, C. A., de Oliveira, S. Q., da Silva Vieira, A. A., Biavatti, M. W., Ritter, C., Reginatto, F. H., de Campos, A. M., & 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.

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.

Wang, F., Zhu, H., Hu, M., Wang, J., Xia, H., Yang, X., Yang, L., & 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.

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., Ihsan, A. 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.

Yang, Z., Wang, D., Li, Y., Zhou, X., Liu, T., Shi, C., Li, R., Zhang, Y., Yan, J., & 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*.