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Case Report

Management of Type 2 Diabetes Mellitus Through Effective Traditional Siddha Therapeutic Interventions: A Comprehensive Case Report

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Abstract

Introduction*:* Diabetes mellitus (DM) is a chronic metabolic disorder marked by persistent hyperglycaemia. This condition may result from impaired insulin secretion, resistance to insulin's peripheral actions, or a combination of both. DM represents a substantial global public health concern. Case Presentation*:* A 65-year-old male patient with Type 2 Diabetes Mellitus (T2DM) presented with multiple clinical manifestations over the last 4 years. Laboratory investigations indicated a fasting blood sugar (FBS) level of 186 mg/dl and a postprandial blood sugar (PPBS) level of 310 mg/dl. The glycosylated haemoglobin (HbA1C) was recorded at 9.4%. Methods: The treatment regimen was tailored according to the imbalanced humors, and the following medications were prescribed: *D5 Chooranam, Seenthil Chooranam, Keelanelli Mathirai, Amukkara Kizhangu Chooranam,* and *Kuntirika Thailam*. Results: After a follow-up period of three months, there was a noted reduction in the frequency of micturition and itching in the inguinal region, along with a slight increase in body weight from 54 kg to 55.3 kg. Over a 12-month period, the patient's weight further increased to 59 kg. Additionally, the HbA1c levels showed significant improvement, decreasing from 9.4% (uncontrolled) to an ideal target of 6.9% over a period of 12 months and 26 days. Conclusion*:* The current treatment protocol emphasizes that through accurate diagnosis and collaborative efforts, along with adjustments in diet and lifestyle, diabetes mellitus can be effectively managed. This approach leads to a notable decrease in Hb A1c levels in a cost-efficient and safe way, without causing adverse effects, thereby reducing the economic burden on society.

Keywords: Ayush, Case report, Diabetes mellitus, Herbal medicine, Siddha.

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Introduction

Diabetes mellitus (DM) is a chronic metabolic disorder marked by persistent hyperglycaemia, which can result from impaired insulin secretion, resistance to insulin's peripheral actions, or both. According to the International Diabetes Federation (IDF), around 415 million adults aged 20 to 79 had diabetes mellitus in 2015. By 2017, the global prevalence of DM had risen to 425 million, and this number is projected to increase by another 200 million by 2040, underscoring DM as a significant global public health burden. Chronic hyperglycaemia, along with other metabolic abnormalities in diabetes mellitus patients, can damage various organ systems, leading to severe and life-threatening complications. The most notable of these are microvascular complications (retinopathy, nephropathy, and neuropathy) and macrovascular complications, which result in a two-to-fourfold increased risk of cardiovascular diseases (1). DM can be broadly categorized into three types based on aetiology and clinical presentation: type 1 diabetes, type 2 diabetes, and gestational diabetes (GDM). Other less common forms include monogenic diabetes and secondary diabetes (2). Type 2 diabetes mellitus (T2DM) accounts for about 90% of all diabetes cases. In T2DM, the body's response to insulin is reduced, a condition known as insulin resistance. Initially, this is countered by increased insulin production to maintain glucose homeostasis, but over time, insulin production declines, leading to T2DM (3). T2DM is most

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frequently seen in individuals over 45 years old, but it is becoming increasingly common in children, adolescents, and younger adults due to rising obesity rates, physical inactivity, and energy-dense diets (4).

Over the last few decades, India has witnessed a significant rise in the occurrence of T2DM, with rates climbing from 5.0% in 1980 to 7.3% in 2000, and further reaching 8.8% by 2014. According to the IDF, the number of individuals with diabetes in India was estimated at 77 million in 2019, and this figure is expected to grow to 134 million by 2045. This increasing burden places a considerable economic strain on patients, healthcare systems, and society as a whole (5).

In a recent publication of the WHO International Standard Terminologies on Siddha Medicine published by the World Health Organization, diabetes was correlated with *Inippu Neer* or *Matumekam* (term ID: ISMT-4.11.40) (6). In India, numerous Siddha formulations are currently employed in the management of diabetes. These formulations comprise various components, including herbs, minerals, metals, and marine-derived substances (7). This paper presents details of a *Matumekam* (T2DM) case managed with Siddha sastric medications and Siddhar Yogam, alongside dietary and lifestyle modifications as outlined in Siddha literature.

Patient Information

On February 3, 2024, a 65-year-old male patient visited the Geriatric Outpatient Department (OPD) at the Siddha Clinical Research Unit in Safdarjung Hospital, New Delhi (SCRUND). He presented with several complaints, including generalized weakness, a mild burning sensation in both the palms and foot regions, increased urinary frequency at night (2 to 3 times per night), mild itching in both inguinal areas, and weight loss of 3 kg (from 57 kg to 53 kg) over the past two months. The patient also reported sleep disturbances due to frequent urination. The patient is a retired IT professional and has a history of T2DM from the last four years. He has a strong family history of T2DM, with both his father and older brother diagnosed with this condition. The patient had no history of systemic hypertension, thyroid dysfunction, or any other comorbidities or autoimmune disorders. He also does not smoke or chew pan but has a history of occasional alcohol consumption over the past 15 years. Additionally, the patient followed a mixed diet. Between December 2018 and March 2019, he experienced increased nighttime urinary frequency, weight loss, and burning sensations in both hands. During this period, he visited a nearby healthcare centre where an allopathic physician advised him to undergo haematological investigations and routine urine examinations. Blood tests revealed elevated fasting blood sugar (FBS) levels and glycosylated haemoglobin (HbA1c) levels. Consequently, the physician prescribed diabetic medication along with other medications on the basis of his or her clinical features. The patient adhered to allopathic medications for two years but stopped taking them on his own in August 2022. Since then, he has experienced fluctuating HbA1c levels over the past 1.5 years.

Clinical Findings

At the time of the patient visit, he reported experiencing weight loss, generalized weakness, itching, frequent urination, and a burning sensation in both foot regions. Additionally, the patient experienced sleep disturbances. During the general examination, the patient's appetite and bowel movements were normal. The pulse rate was 76 beats per minute, the blood pressure was 128/84 mm Hg, and the body temperature was within the normal range. Her height was 162 cm, her weight was 54 kg, and her BMI was 21.3 kg/m^2.

Upon systemic examination, the cardiorespiratory, musculoskeletal, and neurological systems appeared normal. In the abdominal examination, the palpitations were normal. Normal movements were observed during respiration, and no dull sounds were detected on percussion. Additionally, bowel sounds were found to be normal upon auscultation.

In accordance with Siddha medicine, the patient was examined via the eightfold diagnostic method known as *Envagai Thaervu*. The assessments conducted were as follows: pulse examination- *kapavatham*, tongue examination- mild coated present, examination of the colour of the body – affected (reddish patches present), examination of skin -affected (itching present), Speech examination– normal, no abnormal sound detected, eye examination - normal, stool examination - normal, urine examination- increased urinary frequency. According to the Siddha medicine examination methods, the assessments of *tongue, colour of the body, skin and urine* were affected.

Timeline

In the present case, treatment was administered over a 12-month period, from 03/02/2024 to 06/02/2025. Table 1 outlines the timeline of events in the current case study, detailing symptoms, previous treatments, and Siddha interventions.

Diagnostic findings

On 03/02/2024, the FBS result was 186 mg/dl, and the postprandial blood sugar (PPBS) test result was 310 mg/dl. The HbA1c level was 9.4%. According to the Siddha literature, the clinical features of T2DM are polyuria, dryness of mouth, polydipsia, polyphagia, weight loss, weakness /tiredness, unconsciousness, giddiness, Scabies and itching. Other Siddha studies also mentioned other clinical features. The following clinical features of the patient correlate with the symptoms of T2DM: weakness/tiredness, polyuria, itching, weight loss. The guidelines published by the Indian Council for Medical Research (ICMR), entitled ICMR Guidelines for Management of Type 2 Diabetes 2018, mention the diagnostic criteria for diabetes and prediabetes and treatment targets for metabolic control in diabetes (8).

In the present case, the patient reported experiencing a burning sensation in both the palm and foot regions. The patient exhibited poorly managed diabetes and a history of chronic alcohol use.

Based on the clinical features, prior medical history, blood investigations, adherence to ICMR guidelines, and comprehensive clinical assessment incorporating both allopathic and Siddha approaches, the patient was diagnosed with Type 2 Diabetes Mellitus accompanied by Diabetic Peripheral Neuropathy (DPN).

Subjective Parameters

The following subjective parameters were evaluated, with scores assigned as follows: Severe: 3, Moderate: 2, Mild: 1, and None: 0. The parameters assessed include polyuria, polydipsia, weight loss despite polyphagia, recurrent urogenital infections, delayed wound healing, tiredness, weakness, itching, and sleep disturbances. These subjective parameters are delineated in the ICMR guidelines (8). Based on previous research (9), a Numeric Rating Scale has been developed for these symptoms to facilitate a comprehensive assessment of each symptom's feasibility. The method for evaluating these subjective parameters is presented in Table 2 and Table 3.

Objective Parameters

The treatment prognosis was evaluated using the Treatment Targets for Metabolic Control in Diabetes scale, as published by the ICMR (8). In order to evaluate the safety profile of Siddha classical medicine, the following parameters have been assessed. Blood investigations, including Complete Blood Count (CBC), Erythrocyte Sedimentation Rate (ESR), Haemoglobin (Hb), Liver Function Tests, Renal Function Tests, Lipid Profile, and Routine Urine Examination, were conducted before treatment and again at 6th and 12th months during the treatment period. The results are shown in Table 4. FBS and PPBS levels were measured prior to treatment and subsequently measured throughout the treatment period, as represented in Table 5. Additionally, HbA1c levels were assessed before treatment and at the 3rd, 6th, 9th, and 12th months of the trial, with results detailed in Table 6.

Therapeutic Intervention

Due to the patient's HbA1c level, the Siddha physician recommended an integrated approach that included both Siddha medicines and allopathic medication. However, the patient expressed regret about taking the allopathic medication and preferred to continue with only the stand-alone Siddha treatment. Following this, the patient instructed to follow a treatment protocol that included Siddha medicines, dietary changes, and lifestyle modifications based on the foundational concepts of Siddha medicine and the Siddha Standard Treatment Guidelines published by the Ministry of Ayush (10). The patient was instructed to attend follow-up appointments at the hospital at fifteen-day intervals, and during every visit, clinical assessments and prognoses were recorded.

The treatment protocol included the following:

1. *D5 Chooranam* (medicated herbal powder): 2 grams twice a day (morning and night) before meals, taken with warm water.

2. *Seenthil Chooranam* (medicated herbal powder): 2 grams twice a day (morning and night) after meals, taken with warm water.

3. *Keelanelli Mathirai* (medicated herbal tablet) (each tablet, 500 mg): 2 tablets were taken with warm water twice a day (morning and night) after meals.

4. *Amukkara Kizhangu Chooranam* (medicated herbal powder): 2 grams at bedtime after meals, taken with milk.

5. *Arugan Thailam* (medicated herbal external oil): 5 ml for external application to both inguinal regions (for itching).

6. *Kuntirika Thailam* (medicated herbal external oil): 5 ml for external application to both knees (for knee pain).

The prescribed diet modification chart is presented in Table 7 (10).

Follow-Up and Outcomes

During the siddha treatment period, the Naranjo Adverse Drug Reaction Probability Scale was used to analyze the adverse reactions (11). Throughout the Siddha treatment period, there were no reported adverse drug reactions, and the patient completed the medication without experiencing any complications. During the first visit, the patient presented with increased frequent urination, sleep disturbances, weight loss, a burning sensation in both feet, generalized weakness, and itching. The first follow-up occurred 15 days after the initial visit. At that time, the patient was stable and reported no new complaints.

During follow-up visits, a progressive improvement in clinical features was observed, with complete resolved of clinical features by the fifth month. It represents Table 3. Body weight showed a gradual improvement over the treatment period. The patient's weight increased over time: 54 kg (1st month), 55.3 kg (3rd month), 57 kg (5th month) and 59 kg (12th month). Haematological parameters remained within normal limits throughout the treatment period. It represents Table 4.

Glycaemic parameters also showed significant improvement, with reductions in FBS, PPBS, and HbA1c levels confirmed by a one-sample t-test ($p < 0.05$). It represents Table 5 and 6. The intervention resulted in a reduction of HbA1c levels from 9.4 to 7.625, indicating a significant health impact. This study utilized a single-case design to gather repeated measurements, thereby establishing a comprehensive dataset for analysis. A one-sample t-test was subsequently conducted to evaluate whether the mean score exhibited a statistically significant difference from the reference value, thereby enhancing the statistical rigor of the study. The mean HbA1c level demonstrated statistical significance with a P-value of 0.008, also below the 0.05 threshold. It represents detailed in table 8.

Discussion

Insulin resistance is the main pathological process that results in persistent high blood sugar levels in people with diabetes. T2DM arises due to the activation of various pathways and factors that lead to both insulin resistance and dysfunction of β-cells. These two conditions insulin resistance and β-cell dysfunction are the key features of T2DM, stemming from an imbalance in metabolic homeostasis (12). The development of insulin resistance in T2DM is heavily impacted by several factors, such as adipose tissue, which accelerates lipolysis, the gastrointestinal tract, where there is either a deficiency or resistance to incretins, α-cells that cause hyperglucagonemia, kidneys that show increased glucose reabsorption, and the central nervous system, where insulin resistance is common. Additionally, the intricate interactions between these components and genetic factors associated with T2DM play a crucial role in the pathophysiology of this disease (13). Effectively managing T2DM can be significantly improved through lifestyle changes. While medications have limited long-term effectiveness, important adjustments such as increasing physical activity, improving diet, managing stress, and enhancing sleep quality are essential for effectively managing the condition (14).

Complementary and alternative medicine (CAM) offers promising, cost-effective, and accessible approaches for managing T2DM. Studies suggest that combining CAM with traditional treatments can improve clinical outcomes while also reducing the financial strain of treatment (15). In recent times, there has been a significant rise in the use of natural products (NPs) for treating type 2 diabetes mellitus. As a result, the effects and mechanisms behind NPs have garnered growing interest from both academic and clinical communities (16).

A wide variety of Siddha formulations are currently employed in India for the effective management of diabetes. *D5 Chooranam* is a patented Siddha medicine specifically formulated for the management of diabetes. It was acquired by the Central Council for Research in Siddha, which aims to promote research and development in traditional Siddha medicine. *D5 Chooranam* is a ~~classical~~ polyherbal formulation comprised of several medicinal plants, including *Cassia auriculata* L, *Cassia fistula* L, *Syzygium cumini* (L.) SKEELS,

Salacia oblonga WALL, *Cyperus rotundus* L, *Costus speciosus* (KOEN. EX RETZ.) SM, and *Cinnamomum verum* PRESL. Each ingredient has independently demonstrated antidiabetic properties and additional pharmacological activities The antidiabetic efficacy of the synergistic compound D5 was evaluated in streptozotocin-induced diabetic rats, demonstrating a significant reduction in fasting blood glucose levels, blood urea, creatinine, serum total cholesterol, and triglycerides (7). Histopathological examination of the pancreatic tissue revealed regeneration of the islet cells of Langerhans (7). Additionally, an open-label, multi-center clinical trial involving diabetic patients indicated a marked improvement in HbA1c and postprandial glucose levels (7). C. auriculata and its phytoconstituent (2-ethyl hexyl) phthalate (DEHP) have demonstrated antidiabetic properties (17). Cassia fistula also exhibits antidiabetic activity (18). Mycaminose, derived from S. cumini seeds, reduces blood glucose levels through a mechanism akin to that of Glibenclamide (19). Cinnamon polyphenols, including eugenol and pyrogallol, exhibit antidiabetic properties by promoting beta cell regeneration and facilitating hypoglycemic effects (19). S. oblonga contains alpha-glucosidase inhibitors, such as salacinol and kotalanol, as well as the aldose reductase inhibitor kotalaganin 16-acetate, all of which contribute to its hypoglycemic activity (20). The ethanolic extract of Cyperus rotundus (250 and 500 mg/kg) has shown antidiabetic effects, improved body weight, and reduced biochemical parameters (21). Methanol extracts from the leaves of Costus speciosus have been found to inhibit α-glucosidase, fructosamine formation, glycation, and glycation-induced protein cross-linking, thereby supporting their hypoglycemic properties (22).

Seenthil Chooranam is an innovative formulation within Siddha sastric medicine that incorporates the herbs *Seenthil* (*Tinospora cordifolia* (WILLD.) HOOK.F. & THOMS) and *Karisalai* (*Eclipta prostrata* (L.) L). This medicine is utilized for the management of autoimmune disorders, orchitis, bronchitis, diabetes and tuberculosis. *Seenthil Chooranam*, it exhibits antidiabetic, anti-inflammatory, and hepatoprotective properties. The antidiabetic efficacy of *Seenthil Chooranam* was evaluated in alloxan-induced diabetic rats over a period of five weeks. Oral administration of doses ranging from 100 to 300 mg/kg demonstrated hypoglycemic effects comparable to those of glibenclamide at a dosage of 10 mg/kg, effectively reducing blood glucose levels in diabetic rats (23). *Tinospora cordifolia* (WILLD.) HOOK.F. & THOMS exhibits anti-diabetic properties by regulating blood glucose levels through mechanisms such as enhancing insulin secretion, mitigating oxidative stress, and reducing both gluconeogenesis and glycogenolysis (24). The methanol extract of *Eclipta prostrata* (L.) L showed moderate α-amylase inhibitory activity, with an IC50 value of 322.138 ± 0.025 µg/mL, suggesting potential antidiabetic properties. Significant antihyperglycemic effects were also observed in alloxan-induced diabetic rats (25).

Keelanelli Mathirai (*Phyllanthus amarus* SCHUM. & THENN) is a single-herb medicine primarily used to treat conditions such as jaundice, liver diseases, matumēkam, and syphilitic ulcers. This plant is an important component of the Siddha medicinal system and is widely utilized by traditional practitioners to address various liver diseases, including jaundice, hepatitis, hepatomegaly, liver cirrhosis, and diabetes (26). Bhushan et al. conducted a comprehensive study into the extract of *Phyllanthus niruri* SENSU HOOK.F.Non Linn. (PNE), focusing on its phenolic and terpenoid constituents. The study assessed the antioxidant properties and antidiabetic effects of PNE in mice induced with streptozotocin (STZ). The research identified phytochemicals such as Astragalin, Gallocatechin, and Ellagic acid, which demonstrated significant inhibition of the DPP-IV protein. These findings indicate that the phytochemicals present in PNE may contribute to diabetes management through targeting DPP-IV (27). Preclinical studies indicate that the phytochemicals found in *Phyllanthus amarus* SCHUM. & THENN may possess significant potential for applications in the management of type 2 diabetes (28, 29).

Peripheral neuropathy encompasses a range of potential causes, among which DPN is the most prevalent subtype. DPN can result in severe complications, including paraesthesia and the risk of limb loss or mortality. Given the high incidence of peripheral neuropathy in patients with diabetes, the American Diabetes Association (ADA) advises that clinicians conduct evaluations for individuals with type 2 diabetes at the time of diagnosis. In patients with type 1 diabetes, assessment for peripheral neuropathy should occur five years after diagnosis and then on an annual basis. Patients typically present with a variety of symptoms, including numbness, tingling, aching, burning sensations, limb weakness, hyperalgesia, allodynia, and pain. The key risk factors for the development of DPN include poor glycaemic control, prolonged diabetes, and chronic alcohol consumption (30). In cases of diabetic neuropathy, maintaining strict glycemic control is essential. For individuals experiencing persistent and treatment-resistant painful neuropathies, secondary medications, including opioids such as tramadol, are also recommended. Within the framework of Siddha medicine, the formulations *Seenthil Chooranam* and *D5 Chooranam* have been identified as beneficial alternatives (7). Furthermore, Tinospora cordifolia mitigates hyperalgesia in experimental models of diabetic neuropathy. It exhibits aldose reductase inhibitory activity in vitro, which may contribute to its therapeutic effects (31).

Amukkara Kizhangu Chooranam (*Withania somnifera* DUNAL) is a traditional Siddha medicine derived from a single herb known for its therapeutic properties. It is utilized primarily to address conditions such as *Vali azhal noigal*, loss of appetite, and involuntary weight loss. Additionally, this herbal formulation is reputed for its ability to strengthen the nervous system, thereby enhancing overall vitality and well-being (32). In the present case report, we evaluated a patient who experienced pronounced and gradual weight loss, which raised concerns about their nutritional status and overall health. Given the potential benefits of *Amukkara Kizhangu Chooranam*, it was selected as a key component of the patient's treatment protocol. The treatment regimen followed established guidelines, ensuring the dosage was tailored to the patient's needs. During the study, the patient's weight increased from 54 kg to 59 kg, suggesting that *Amukkara Kizhangu Chooranam* may be an effective option for those experiencing weight loss and nutritional deficiency.

Haemoglobin A1c is often utilized as an outcome measure to determine the success of an intervention in a population by showing a decrease in HbA1c by a certain percentage (33). In this case, the HbA1c levels gradually decreased from 9.4% (uncontrolled) to an ideal target of 6.9% over a period of 12 months and 26 days. These data are presented in Table 7, which clearly demonstrates the promising antidiabetic activity of the therapeutic regimens outlined.

Research indicates that Siddha therapeutic interventions exert notable antidiabetic effects by modulating insulin secretion, addressing β-cell dysfunction, and enhancing glucose uptake. These treatments effectively manage blood glucose levels in patients with type 2 diabetes mellitus (T2DM) and mitigate

complications such as cardiovascular issues, neuropathy, and renal damage. The integration of Siddha interventions presents a promising approach for improving the quality of life in diabetic patients.

Conclusion

The findings provide compelling evidence that the intervention is demonstrably effective in the present case report. Furthermore, it is essential to conduct more extensive clinical studies involving larger patient populations to evaluate the effectiveness of Siddha management for T2DM robustly.

Patient Perspective

My friend recommended that I try Siddha medications for my diabetes. Since February 2024, I have been taking Siddha medicines. Before starting the treatment, I experienced many complications, and my blood sugar levels fluctuated significantly. However, after beginning the Siddha medications, my symptoms gradually reduced, and my HbA1c level also decreased over time. After a one-year follow-up period, my blood sugar levels are now under control, and I no longer have any symptoms. Following the treatment, I checked my HbA1c level twice, and it has remained within the normal range. Additionally, the Siddha physician advised me to continue with these medications, as well as to follow certain lifestyle and diet modifications to help manage my diabetes.

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Declaration of generative AI in scientific writing

The authors declare that no artificial intelligence tools were used during the preparation of the manuscript.

Data statement

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Informed Consent

Written permission for publication of this case study was obtained from the patient.

Abbreviations

DM, Diabetes mellitus; T2DM, Type 2 Diabetes Mellitus; FBS, fasting blood sugar; HbA1C, glycosylated haemoglobin; IDF, International Diabetes Federation; GDM, gestational diabetes; OPD, Outpatient Department; SCRUND, Siddha Clinical Research Unit New Delhi; PPBS, postprandial blood sugar; ICMR, Indian Council for Medical Research; DPN, diabetic peripheral neuropathy; ADA, American Diabetes Association; CBC, Complete Blood Count; ESR, Erythrocyte Sedimentation Rate; Hb, Haemoglobin; CAM, Complementary and alternative medicine; NPs, natural products; PNE, Phyllanthus niruri.

Table 1: Timeline of the events of the present case report

S. No	Timelines of the events	Chief Complaints	Allopathic Interventions/Siddha Interventions
1	March 2019	Patient Diagnosed as T2DM	Metformin 500 mg BD, after food
2	March 2019 to August 2022	The HbA1C level fluctuated and Mild Diabetic Neuropathy present.	Metformin 500 mg BD, after food and According to the other clinical features the allopathic medications were prescribed by Allopathy Physician.
3	August 2022	T2DM with early stage of Osteoarthritis	patient withdrawn medication himself
4	August 2022 to January 2023	T2DM	No medications. Followed physical exercise and diet modifications.
5	03/02/2024	Generalized weakness, sleep Disturbances, weight loss, frequent micturition, burning sensation in foot region. Blood investigations showed abnormal FBS, PPBS and HbA1c levels.	1st Visit at Siddha Clinical Research Unit, Safdarjung Hospital, New Delhi
6	03/02/2024 to 04/05/2024	T2DM	1.*D5 Chooranam*- 2 grams twice a day (morning and night) before food with warm water 2. *Seenthil Chooranam*- 2 grams twice a day (morning and night) after food with warm water 3. *Keelanelli Mathirai* (tablet- 500 mg) 2 tablets twice a day (morning and night) after food with warm water. 4. *Amukkara Kizhangu Chooranam*- 2 grams (hours of sleep) after food with milk 5. *Arugan Thailam*- 5 ml (external application)
7	04/05/2024 to 03/08/2024	T2DM with mild knee pain. Other clinical features reduced	1.*D5 Chooranam*- 2 grams twice a day (morning and night) before food with warm water 2. *Seenthil Chooranam*- 2 grams twice a day (morning and night) after food with warm water 3. *Keelanelli Mathirai* (tablet- 500 mg) 2 tablets twice a day (morning and night) after food with warm water. 4. *Amukkara Kizhangu Chooranam*- 2 grams (hours of sleep) after food with milk 5. *Arugan Thailam*- 5 ml (external application to both inguinal regions)6. *Kuntirika Thailam*- 5 ml (external application to both knees)

8	03/09/2024 to 07/11/2024	T2DM with mild knee pain	1.*D5 Chooranam*- 2 grams twice a day (morning and night) before food with warm water 2. *Seenthil Chooranam*- 2 grams twice a day (morning and night) after food with warm water 3. *Keelanelli Mathirai* (tablet- 500 mg) 2 tablets twice a day (morning and night) after food with warm water. 4. *Amukkara Kizhangu Chooranam*- 2 grams (hours of sleep) after food with milk 5. *Kuntirika Thailam* 5 ml (external application to both knees)
9	07/11/2024 to 06/02/2025	T2DM	1.*D5 Chooranam*- 2 grams twice a day (morning and night) before food with warm water 2. *Seenthil Chooranam*- 2 grams twice a day (morning and night) after food with warm water 3. *Amukkara Kizhangu Chooranam*- 2 grams (hours of sleep) after food with milk 4. *Kuntirika Thailam* 5 ml (external application to both knees)
T2DM - Type 2 Diabetes Mellitus, HbA1c - Glycosylated Haemoglobin. BD- Twice a day, mg- milligram			

Table 2: Subjective Parameters for Assessment with Grading System

Subjective parameters	0	1	2	3
Polyuria	3 – 5 times per day, rarely at night	6 – 8 times per day, 1 – 2 times per night	9 – 11 times per day 3 – 4 times per night	> 11 times per day > 4 times per night
Polydipsia	No thirst	Drinking water satisfy the thirst, dryness of mouth, throat	Frequent feel to drink water	Severe (Feeling of severe thirst, waking up night to drink)
Weight loss in spite of polyphagia	No appetite/very poor	Occasional hunger/ eating only few mouthful/one third plate	Two to three meals per day, comfortable, neither hungry nor full	Feeling hungry all the time with several hunger symptoms
Recurrent Urogenital infections	None	Mild	Moderate	Severe
Delayed Healing of Wounds	Nine	Mild	Moderate	Severe
Tiredness, Weakness	None	Mild	Moderate	Severe
Itching	None	Mild	Moderate	Severe
Sleep Disturbances	None	Mild	Moderate	Severe [8]

Table 3: Assessment of subjective parameters before and during follow-up visits and after treatment

Subjective parameters	Before Treatment (day 0)- 03.02.2024	1st Month of the treatment (04.03.2024)	3rd Month of the treatment (04.05.2024)	6th Month of the treatment (03.08.2024)	9th Month of the treatment (07.11.2024)	12th Month of the treatment- 06.02.2025
Polyuria	**2**	**2**	**1**	**1**	**0**	**0**
Polydipsia	**2**	**1**	**1**	**0**	**0**	**0**
Weight loss in spite of polyphagia	**2**	**2**	**1**	**0**	**0**	**0**
Recurrent Urogenital infections	**1**	**1**	**1**	**0**	**0**	**0**
Delayed Healing of Wounds	**0**	**0**	**0**	**0**	**0**	**0**
Tiredness, Weakness	**2**	**2**	**0**	**0**	**0**	**0**
Itching	**2**	**2**	**1**	**0**	**0**	**0**
Sleep Disturbances	**2**	**1**	**0**	**0**	**0**	**0**

Table 4: Laboratory investigations before treatment and during follow-ups

Laboratory Investigations	Before Treatment (03.02.2024)	6th Month (03.08.2024)	12th Month (06.02.2025)	Reference range
Blood Investigations				
Neutrophils (%)	62	60	64	40-75
Lymphocytes (%)	28.5	29.9	27.1	20-45
Eosinophils (%)	6.3	5.2	4.1	1-6
Monocytes (%)	3	4	4	2-10
Basophils (%)	0	0.1	0.1	0-1
Hemoglobin (g/dl)	14.5	14.7	15.2	13.5- 18
RBC Count (millions/cmm)	5.0	4.9	5.3	4.5 to 6.5

Platelet count (cells/cmm)	2, 80, 000	2, 90, 000	3,10, 000	150000-400000
ESR (%)	12	14	11	0-15
Total WBC Count (cells/cmm)	5756	5810	6200	4000-11000
T. Bilirubin (mg/dL)	0.9	0.82	0.89	< 1.3
D. Bilirubin (mg/dL)	0.3	0.3	0.36	0-0.3
In. Bilirubin (mg/dL)	0.6	0.52	0.53	0.1-1
SGOT (U/L)	31	33	30	15-37
SGPT (U/L)	42	39	44	16-63
ALP (U/L)	114	99	81	50-136
T. Protein (gm/dL)	6.9	6.7	6.3	6.4-8.3
Globulin (g/dL)	3.3	3.2	3.3	2.6-3.7
Albumin (gm/dL)	4.1	4.1	3.9	3.4-5.0
T. Cholesterol (mg/dL)	182	174	156	<200
Triglycerides (mg/dL)	94	83	89	< 150
Serum Urea (mg/dL)	22	19	21	19.0 – 44.1
Serum Creatinine (mg/dL)	0.7	0.7	0.6	0.5-1.4
Serum Uric Acid (mg/dL)	4.8	4.6	5.1	3.5 – 7.2
Urine Routine Analysis				
Appearance	Clear	Clear	Clear	Clear
Color	Pale Yellow	Pale Yellow	Pale Yellow	Straw to Yellow
pH	5.1	5.0	5.1	5-9
Specific Gravity	1.012	1.019	1.010	1.000- 1.030
Glucose	++	Nil	Nil	Absent
Bile Salt	Absent	Absent	Absent	Absent
Bile Pigments	Absent	Absent	Absent	Absent
Urobilinogen	Normal	Normal	Normal	Normal
Protein	Nil	Nil	Nil	Absent
Urine Microscopic Examination				
Crystals	Absent	Absent	Absent	Absent
RBC'S/Hpf	Absent	Absent	Absent	0-2
Pus Cells/Hpf	1-2	2-3	1-2	0-5

RBC- Red Blood Cell Count, ESR- Erythrocyte Sedimentation Rate, SGOT- Serum Glutamic-Oxaloacetic Transaminase, SGPT- Serum Glutamic Pyruvic Transaminase, ALP- Alkaline Phosphatase

Table 5: Fbs and Ppbs levels before and during follow-up visits and after treatment

Follow- up Visits	FBS (mg/dl)- Reference Range- Normoglycemia(mg/dl)- < 110, Prediabetes- 110-125, Diabetes- ≥ 126	PPBS (mg/dl)- Reference Range- Normoglycemia(mg/dl)- < 140, Prediabetes- 141-199, Diabetes- ≥ 200
Before Treatment (03.02.2024)	186	310
1st Month (04.03.2024)	164	273
2nd Month (05.04.2024)	128	228
4th Month (09.06.2024)	114	161
6th Month (03.08.2024)	99	160
8th Month (08.10.2024)	102	154
10th Month (04.12.2024)	96	146
12th Month (06.02.2025)	98	132

Table 6: Assessment of HbA1c levels before treatment and during follow-up visits

Follow- up Visits	Laboratory Investigations- HbA1c (%)- Reference Range- Normoglycemia- < 5.7, Prediabetes- 5.7-6.4, Diabetes- ≥ 6.5%
Before Treatment (03.02.2024)	9.4
04.05.2024 (3 months and 16 days)	8.2
03.08.2024 (6 months and 1 day)	7.9
07.11.2024 (9 months and 5 days)	7.5
06.02.2025 (12 months and 4 days)	6.9

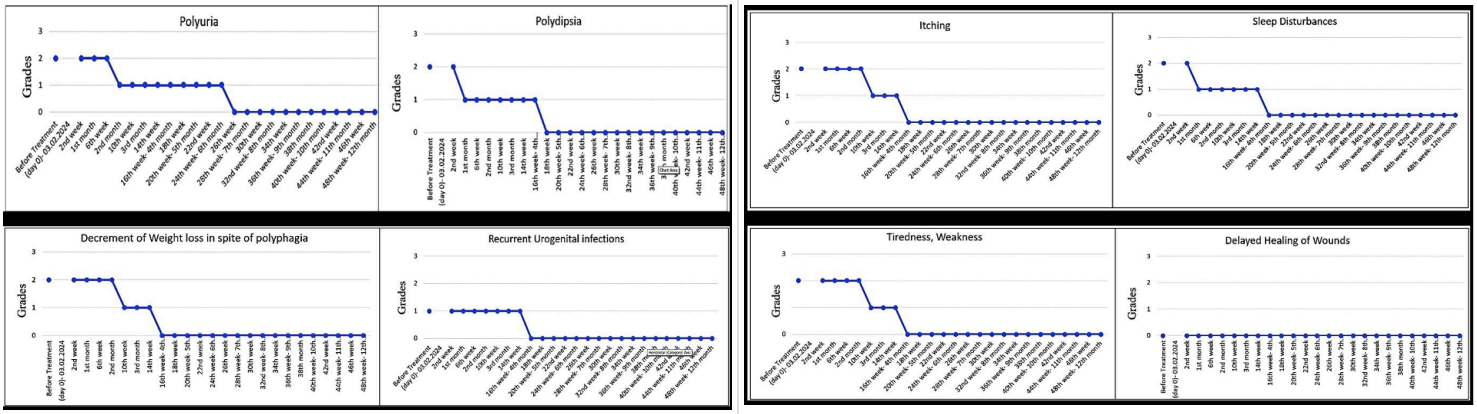
Table 7: Chart of diet modifications (10)

To be added		To be avoided
Hand pounded boiled rice	Raphanus sativus	Sweets
Oryza sativa	Allium cepa	Bakery products such as cakes, pastries, cream biscuits,
Triticum aestivum	Coriandrum sativum	concentrated milk preparations such as pedha, burfee, etc
Pennisetum typhoides	Mentha arvensis	Ice-cream
Setaria italica	Murraya koenigii,	soft drinks
Momordica charantia	Centella asiatica	fruit juices
Lagenaria siceraria	Psidium guajava	Saturated fats like vanaspathy, dalda, ghee, and butter
Abelmoschus esculentus	Punica granatum	Fatty meat cuts
Lablab purpureus	Carica papaya	
Moringa oleifera	Phyllanthus Emblica	

Table 8: Results of the statistical analysis of Fbs, Ppbs and HbA1c

FBS		PPBS		HbA1c	
Statistic	**Value**	**Statistic**	**Value**	**Statistic**	**Value**
Baseline Value (μ_0)	186	Reference Value (μ_0)	310	Reference Value (μ_0)	9.4
Sample Mean ($\bar{x}$)	114.43	Sample Mean ($\bar{x}$)	179.14	Sample Mean ($\bar{x}$)	7.625
t-statistic	-7.68	t-statistic	-6.737	t-statistic	-6.32
Degrees of Freedom	6	Degrees of Freedom (df)	6	Degrees of Freedom (df)	3
p-value	**0.00025**	p-value	**0.00052**	p-value	**0.008**
95% Confidence	91.64 to 137.22	95% Confidence Interval	[131.62, 226.67]	95% Confidence Interval	[6.73,
		Conclusion	Significant reduction in mean ($p < 0.001$)		

Fig 1: Assessment of clinical features and its prognosis



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