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Recent developments in Integrated Medicine Approach in management of Type 1 and Type 2 Diabetes Mellitus: A Review

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ABSTRACT

Type 2 Diabetes Mellitus (T2DM) is a chronic metabolic disorder of growing global health concern characterized by insulin resistance and elevated blood sugar levels. While conventional medications offer significant benefits, they often come with adverse effects such as gastrointestinal disturbances and weight gain. Ayurveda, an ancient Indian system of medicine, provides a holistic alternative through the use of herbal and herbo-mineral formulations. Ayurveda and Yoga have emerged as complementary therapies with promising potential in diabetes management. This review discusses Ayurvedic formulations like Ayush- 82, PANHEAL, Dhanwantaram Kashayam, Shilajatvadi Lauha, and other standardized polyherbal therapies highlighting their efficacy in reducing blood sugar levels, improving insulin sensitivity, have demonstrated significant antioxidant, and lipid-lowering effects, as shown in various preclinical and clinical studies addressing complications related to T2DM. Also, this review explores the effectiveness of Ayurvedic formulations like GlucoCare and holistic modules that combine Panchakarma and Yoga practices. Clinical trials and studies demonstrate that these Ayurvedic interventions offer promising results in managing diabetes without the side effects associated with modern medications. Integrating these traditional therapies with modern treatments may offer a more holistic approach to managing diabetes.

Key words: Ayurveda, diet, lifestyle, type 2 diabetes mellitus, Yoga, integrated medicine

INTRODUCTION

Type 2 Diabetes Mellitus (T2DM) is a chronic metabolic disorder characterized by high blood glucose levels, insulin resistance, and associated complications, including cardiovascular diseases and dyslipidemia.^[1] According to the International Diabetes Federation, India ranks high among countries with the highest

number of diabetic patients. Modern treatments, such as metformin and insulin therapy, are effective in managing blood sugar levels but often lead to side effects like hypoglycemia, gastrointestinal discomfort, and weight gain.^[2,3] With the prevalence of T2DM rising rapidly worldwide, alternative treatments, particularly from traditional medicinal systems like Ayurveda, have gained attention due to their holistic approach and potential to reduce disease burden. Current treatments focus primarily on managing blood glucose levels through pharmaceutical interventions, which often come with side effects and do not address the root causes of the disease, such as lifestyle factors and stress.^[8,10] Ayurvedic medicine, with its focus on balance, lifestyle, and herbal remedies, presents an alternative or complementary treatment pathway for managing T2DM.^[4,5] Complementary and integrative therapies like Ayurveda and Yoga offer an alternative that addresses both the physiological and

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psychological dimensions of diabetes.^[6,7] Few studies explore the potential of combining Ayurvedic herbal treatments with Yoga practices to manage T2DM more effectively. Prior studies have shown that Yoga can improve glycemic control, lipid levels, and reduce obesity. Similarly, Ayurvedic herbs, such as *Amalaki* and *Guduchi*, have demonstrated antihyperglycemic, antioxidant, and immunomodulatory properties.^[8] Modern medicine typically addresses these conditions through pharmacological interventions, but integrative therapies, particularly those involving yoga, naturopathy, and Ayurveda, offer promising non-pharmacological solutions. Such approaches are increasingly recognized for their role in holistic health management, emphasizing lifestyle changes, physical exercise, diet, and stress management.^[17] The rising prevalence of metabolic syndrome (MetS) globally, particularly in South Asian populations, has prompted exploration into integrative medical approaches, including Ayurveda. This review examines the role of polyherbal and herbo-mineral formulations in managing T2DM, focusing on their antioxidant properties, hypoglycemic effects, ability to regulate lipid profiles and also adds insight into Ayurvedic formulations and Yoga as complementary therapies in managing T2DM. This review also focuses on a comparative discussion of two recent studies focused on Ayurvedic formulations - *Tryushnadi Churna* and *Chandraprabha Vati* (CPV) - and their potential role in managing MetS.^[18,19]

Pathophysiology of T2DM in Ayurveda

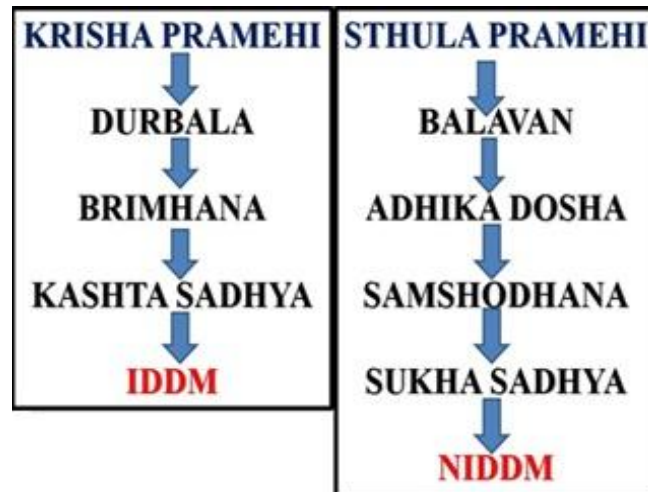
In Ayurveda, diabetes, or *Madhumeha*, is considered a subtype of *Vataja Prameha*, characterized by a predominance of the *Vata Dosha*. This condition arises from impaired digestion (*Agni*), which leads to the accumulation of toxins (*Ama*) and the disturbance of metabolic processes. The imbalance of *Kapha* and *Meda* (fat tissue) is also central to the development of T2DM, with excess *Kapha* leading to insulin resistance and fat accumulation.^[18,19]

Ayurvedic perspective on Diabetes Mellitus and Pre-Diabetes

In Ayurveda, diabetes is referred to as *Madhumeha*, and it is considered one of the most challenging

diseases to treat due to its chronic nature. Many previous works have been done on *Prameha* to study the efficacy of Ayurvedic medicines and treatment on reducing the blood glucose levels however the *Prameha* management principles are not explored in stage/state wise, customized and personalized approach. *Prameha* occurs by derangement of *Tridoshas* and *Dasha Dushyas*. *Sahaja Prameha* occurs by *Matru Pitru Beeja Dosha* and is *Krishna Pramehi*, whereas *Apathya Nimittaja Prameha* occurs due to a faulty lifestyle and is *Sthula Pramehi* which is analogous to Type 2 Diabetes Mellitus. Whereas in *Sthula Prameha* the dominance of *Meda, Kleda, Dushti* and needs the Systems approach by the application of Chikitsa Sutra mentioned by Acharya Sushruta says- "स्थूलम् अपतर्पणयुक्ताभिः ।" (*Sthulam Apatarpana Yuktabhihi*).^[13,14] (Figure -1)

Figure 1: Steps and factors indicating *Krishna* and *Sthula Pramehi* in developing to IDDM and NIDDM respectively



Ayurvedic treatments focus on lifestyle changes, dietary modifications, and the use of herbal formulations to restore balance in the body. Ayurvedic formulations like Ayush-82, PANHEAL, and Shilajatvadi Lauha have been clinically tested for their efficacy in managing T2DM.

Ayurvedic literature attributes diabetes to the imbalance of the body's *Doshas* (*Vata, Pitta, and Kapha*) and the vitiation of tissues such as *Meda* (fat), *Mamsa* (muscle), and *Ojas* (vital energy). Factors such as sedentary lifestyle, improper diet, and genetic

predisposition contribute to the manifestation of this condition.^[14,19]

Prediabetes is a high-risk state where blood glucose levels are elevated but not high enough to be diagnosed as diabetes. Lifestyle interventions and early diagnosis play a crucial role in preventing the progression of prediabetes to full-blown diabetes. Ayurvedic principles emphasize balancing the doshas, detoxifying the body, and enhancing digestive fire (*Agni*) to regulate blood sugar levels.^[18]

GlucCare

Ayurveda offers a range of herbal remedies that aim to regulate blood glucose levels and prevent diabetes-related complications. One such formulation is GlucCare, a polyherbal capsule that has been clinically evaluated for its effects on non-insulin-dependent diabetes mellitus (NIDDM).^[6]

In a double-blind, placebo-controlled trial, 50 NIDDM patients were divided into two groups: one group received GlucCare and the other a placebo. After three months, the GlucCare group showed significant improvements in symptoms such as polyuria, polydipsia, and polyphagia. Fasting blood glucose levels in the GlucCare group dropped from 180 mg/dL to 130 mg/dL, while postprandial blood glucose levels decreased from 200 mg/dL to 140 mg/dL. The placebo group did not exhibit any significant improvement.^[6]

The formulation, which includes ingredients such as *Gymnema sylvestre*, *Momordica charantia*, *Commiphora wightii*, and *Pterocarpus marsupium*, has been shown to enhance insulin secretion, improve pancreatic beta-cell function, and reduce oxidative stress. The study found that GlucCare was well-tolerated, with no reported adverse effects, making it a safe alternative for patients seeking natural treatment options for diabetes.

Ayush-82 and IME-9: Clinically proven Ayurvedic formulations

Ayush-82, developed by the Central Council for Research in Ayurvedic Sciences (CCRAS), is one of the prominent formulations used in the treatment of diabetes. IME-9, a modified version of Ayush-82, has

gained attention due to its effectiveness in reducing blood sugar levels and improving glycosylated hemoglobin (HbA1c) in newly diagnosed diabetic patients. In a retrospective analysis of patients consuming IME-9, it was found that 96% of patients experienced a significant reduction in blood glucose levels. Moreover, 48% of patients showed improvements in HbA1c levels, with no reported adverse effects.^[2,3]

PANHEAL: A Polyherbal Formulation

A clinical trial by Shubha *et al.* (2019) evaluated the efficacy of PANHEAL, which contains a blend of herbs like *Amalaki* (*Emblica officinalis*), *Haridra* (*Curcuma longa*), *Kiratatikta* (*Andrographis paniculata*), and *Katuki* (*Picrorhiza kurroa*), all of which are known for their hypoglycemic properties. In a clinical trial involving 30 subjects with uncontrolled T2DM, PANHEAL was administered for four months. The results indicated a statistically significant reduction in fasting blood sugar (FBS), postprandial blood sugar (PPBS), and HbA1c levels. Additionally, participants reported improvements in diabetes-related symptoms such as fatigue, polyuria, and polydipsia.^[2]

Shilajatvadi Lauha: Herbo-mineral formulation

Shilajatvadi Lauha, a traditional herbo-mineral formulation, combines *Shilajit*, *Swarna Makshika Bhasma* (chalcopryrite), and *Trikatu* (a mixture of ginger, black pepper, and long pepper) to enhance insulin production and reduce blood sugar levels. In an experimental study using diabetic rats, *Shilajatvadi Lauha* significantly lowered fasting blood glucose and improved insulin levels. The formulation also reduces cholesterol and triglycerides, making it beneficial for managing the lipid profile of diabetic patients.^[3,5,11]

The herbal and herbo-mineral formulations discussed in this article work through various mechanisms to manage diabetes. Many of these herbs, such as *Kiratatikta* and *Haridra*, enhance insulin sensitivity and promote pancreatic beta-cell regeneration. The presence of antioxidants like polyphenols and flavonoids in these formulations helps mitigate oxidative stress, which is a common complication in diabetic patients. Additionally, herbs like *Shilajit* and

Katuki regulate glucose metabolism and improve lipid profiles.^[5]

Polyherbal Ayurvedic Formulations

Ayurvedic medicine has long been used to treat metabolic disorders like T2DM, focusing on restoring the balance of *Doshas* and improving overall well-being. Two major Ayurvedic approaches include the use of polyherbal formulations, such as *Dhanwantaram Kashayam*, and standardized formulations studied in clinical trials.

Dhanwantaram Kashayam

Dhanwantaram Kashayam (DK) is an Ayurvedic polyherbal formulation consisting of 40 herbal ingredients. It has been traditionally used for nerve regeneration and as a growth stimulant in children. Recent studies have highlighted its antioxidant and lipid-lowering properties, making it a promising therapy for diabetes.^[4]

In a study conducted on streptozotocin-induced diabetic rats, DK was found to significantly reduce oxidative stress by increasing the levels of antioxidant enzymes such as catalase (CAT), superoxide dismutase (SOD), and glutathione peroxidase (GPx) in various tissues. Additionally, DK administration reduced blood glucose levels and improved lipid profiles by lowering total cholesterol, free fatty acids, triglycerides, and phospholipids. These findings suggest that DK can be developed as a dietary supplement to prevent or alleviate complications associated with diabetes.^[4]

Standardized Polyherbal Formulation

Another Ayurvedic intervention studied in clinical settings involves a standardized polyherbal formulation (PHF). In a randomized, controlled clinical trial conducted on 93 newly diagnosed T2DM patients, the polyherbal formulation demonstrated significant reductions in fasting blood glucose (25.52%) and postprandial blood glucose (24.22%) after 24 weeks of treatment. While the efficacy of PHF in lowering blood glucose was comparable to Metformin, it showed greater effectiveness in reducing total cholesterol levels. PHF-treated patients experienced a mean reduction in cholesterol of 61.3 mg/dL, significantly

more than the 41.12 mg/dL reduction in the Metformin-treated group.^[5] The study also found that PHF improved glycosylated hemoglobin (HbA1c) levels similarly to Metformin, without causing adverse effects on liver or kidney function. This positions PHF as a promising alternative or adjunctive treatment to conventional diabetes medications, especially for patients seeking natural therapies.^[5]

Ayurvedic formulations exert their effects through multiple mechanisms. The antioxidant properties of polyherbal formulations, such as DK, are critical in combating oxidative stress - a key factor in beta-cell dysfunction and the progression of diabetes. Enzymes like SOD, CAT, and GPx help mitigate oxidative damage by scavenging free radicals. Moreover, the lipid-lowering effects of these formulations help prevent cardiovascular complications, which are common in diabetic patients.^[4,5]

Herbs commonly used in Ayurvedic formulations, such as *Emblica officinalis* (*Amalaki*) and *Curcuma longa* (*Haridra*), *Tinospora cordifolia*, and *Cinnamomum tamala* enhance insulin sensitivity and protect pancreatic beta cells from oxidative damage (antioxidant properties). The combination of these herbs in polyherbal formulations enhances their therapeutic efficacy.^[5,10,12]

Herbal treatments such as *Amalaki* and *Guduchi*, which have antioxidant and rejuvenating properties, are likely responsible for the improved glycemic control observed in the study. *Amalaki* is known for its anti-hyperglycemic effects, while *Guduchi* has been shown to stimulate the immune system and reduce stress. The inclusion of Wheatgrass, a non-Ayurvedic herb, in the herbal juice preparation further enhanced the hypoglycemic and lipid-lowering effects.^[8,9,10]

Effect of Panchakarma, Yoga, and Naturopathy

Panchakarma, a detoxification process in Ayurveda, combined with Yoga, is another holistic approach used to manage T2DM. It is a set of detoxification therapies that help to remove accumulated toxins and restore the balance of *Doshas*. For diabetes, therapies such as *Virechana* (therapeutic purgation) and *Basti* (medicated enema) are commonly prescribed. These

therapies cleanse the body of excess *Kapha* and *Meda*, which contribute to insulin resistance and fat accumulation.

1. **Virechana:** This involves administering purgatives like *Triphala* to cleanse the body of excess *Kapha* and *Pitta Doshas*. Studies have shown that *Triphala* helps reduce blood glucose levels and improves lipid metabolism.
2. **Basti (Medicated Enema):** Medicated enemas help detoxify the colon and balance the *Vata Dosha*, which is crucial in treating metabolic disorders like T2DM.
3. **Udwartana:** This is a dry powder massage performed using herbal powders such as *Triphala*. It helps in reducing fat tissue and improving insulin sensitivity by stimulating circulation.

A pilot study conducted by Vaibhavi *et al.* (2013) explored the effects of combining *Panchakarma* therapy with a Yoga-based intervention in 12 patients with T2DM. The intervention included Ayurvedic therapies such as *Deepana* (appetizer) and *Paachana* (digestive drugs), followed by internal oleation and purgation, in conjunction with a structured Yoga therapy program.^[6,7]

After six weeks, significant improvements were observed in fasting blood glucose (a 19.93% reduction) and postprandial blood glucose (a 20.23% reduction). Additionally, glycosylated hemoglobin (HbA1c) levels dropped by 8.19% after six weeks and further reduced by 13.19% after 12 weeks. The study also recorded reductions in total cholesterol (10.56%) and triglycerides (23.71%). Furthermore, the participants' reliance on oral hypoglycemic agents (OHAs) decreased by 64.66%, highlighting the potential of this integrative approach to reduce medication dependency.

The benefits of Ayurvedic formulations and Yoga stem from their multi-faceted mechanisms of action. Herbs like *Gymnema sylvestre* are known to stimulate insulin production and improve glucose uptake by peripheral tissues, while *Momordica charantia* has been shown to regenerate pancreatic beta cells. These herbs also

possess antioxidant properties, which reduce oxidative stress and protect against the long-term complications of diabetes.^[5,7]

Yoga, through physical postures (*Asanas*), breathing exercises (*Pranayama*), and meditation, enhances insulin sensitivity, improves glycemic control, and reduces stress - a key factor in the progression of diabetes. The combination of *Panchakarma* and Yoga creates a holistic approach that not only manages blood sugar levels but also improves overall mental and emotional well-being.^[7,11]

Yoga, on the other hand, has long been recognized for its ability to reduce stress and promote overall well-being. By lowering stress, Yoga helps regulate the *Vata Dosha*, which is closely linked to the hypothalamic-pituitary-adrenal axis and plays a significant role in diabetes management. This study reinforces the notion that a holistic approach integrating both physical and herbal therapies is more effective than single-modal interventions for chronic conditions like T2DM.^[7,8]

Yoga is a vital component of diabetes management in Ayurveda. It not only improves physical health but also reduces stress, which plays a significant role in the progression of T2DM. Regular practice of specific *Asanas* (postures), *Pranayama* (breathing exercises), and meditation can improve insulin sensitivity, lower blood sugar, and enhance mental well-being.

1. **Suryanamaskara:** This sequence of postures improves metabolism and helps regulate insulin production.
2. **Pranayama:** Breathing exercises like *Kapalbhati* and *Nadi Shuddhi* are particularly beneficial for improving glucose tolerance and reducing stress levels.

The Integrated Yoga Naturopathy (IYN) protocol included therapeutic fasting, calorie-restricted diets, hydrotherapy, *Yoga Asanas*, *Pranayama*, meditation, and lifestyle counseling. The integration of these practices aimed to reduce mental and physical stress, promote detoxification, and improve insulin sensitivity. By combining naturopathy's detoxification processes with yoga's ability to manage psychosomatic factors,

the patient achieved long-term benefits. At follow-ups, the patient maintained these health improvements, showcasing the sustainability of the IYN approach.^[17]

Case Studies: Efficacy of integrated approach of Ayurveda in T2DM management

Several case studies have demonstrated the effectiveness of Ayurveda in reversing T2DM. In a case study, a 31-year-old female patient with poorly controlled T2DM (HbA1c of 13.5) was successfully treated with an integrated protocol of Ayurveda diet and yoga. After following a millet-based diet and regular yoga practice for six months, her HbA1c levels dropped to 5.7, indicating near-normal glycemic control. The patient also experienced weight loss, improved insulin sensitivity, and a reduction in triglyceride levels.^[15]

A case study reported by Kumari *et al.* (2022) highlighted the successful treatment of a 52-year-old woman with poorly controlled diabetes using an integrated approach of *Panchakarma*, herbal medications, and dietary modifications. A 52-year-old woman with T2DM was treated using a combination of *Panchakarma*, herbal medications, and Yoga. The patient, who presented with symptoms of frequent urination, excessive thirst, and fatigue, showed significant improvements in fasting blood sugar and HbA1c levels after one year of Ayurvedic treatment. Her weight and waist circumference also decreased markedly, further supporting the efficacy of the intervention.^[16]

Diabetic foot ulcers are a severe complication of diabetes, often leading to amputation if not managed effectively. Standard treatments include surgical debridement, infection control, insulin therapy, and antibiotics. Integrative approaches combine these conventional methods with Ayurvedic therapies such as *Vrana Shodhana* (ulcer cleansing), *Vrana Ropana* (ulcer healing), and *Vrana Dhupana* (ulcer fumigation) to accelerate healing and reduce the risk of further complications.^[19]

In a case series by Shindhe *et al.* (2023), six patients with DFUs were treated using an integrative approach that combined allopathic and Ayurvedic interventions.

The Ayurvedic treatments included the use of herbal medications such as *Kaishore Guggulu* and *Aragwadha Kashaya*, along with local ulcer care procedures like *the Jatyadi Taila* application. These treatments, when combined with surgical debridement and antibiotics, resulted in faster healing, minimal scar formation, and reduced risk of amputation.^[19]

In another case study, Ashtankar *et al.* (2024) described the treatment of a 53-year-old prediabetic female patient using Ayurvedic interventions and lifestyle modifications. The patient, with an initial HbA1c of 6.4%, was treated with herbal medications like *Phalatrikadi Kwath* and advised to follow a specific diet and exercise regimen. Over three months, the patient's HbA1c decreased to 5.6%, and her fasting blood sugar levels normalized without the need for oral hypoglycemic medications.^[18,19]

Ayurvedic interventions, such as *Phalatrikadi Kwath*, contain herbs like *Triphala*, *Musta*, *Daruharidra*, and *Nisha*, which are known for their anti-hyperglycemic properties. These herbs help reduce insulin resistance, improve digestion, and detoxify the body. Additionally, lifestyle modifications such as regular exercise and a balanced diet rich in easily digestible foods like barley, wheat, and green vegetables were essential components of the treatment plan.^[18]

Yoga and naturopathy provide integrative techniques aimed at correcting metabolic imbalances. In a case study by Gowda *et al.* (2017), a 50-year-old male with metabolic syndrome - characterized by obesity, Type 2 diabetes, hypertension, and hypothyroidism - underwent an Integrated Yoga and Naturopathy (IYN) treatment module. Over six weeks, the patient experienced significant improvements, including a reduction in weight (from 97.9 kg to 74.6 kg), BMI (from 35.1 to 27.8), and fasting blood sugar (from 110 mg/dL to 75 mg/dL). Additionally, the patient's postprandial glucose, cholesterol, and blood pressure also showed marked improvement. The integration of yoga, naturopathy, and Ayurveda in managing metabolic conditions is supported by growing clinical evidence. Gowda *et al.* (2017) demonstrated how a tailored yoga and naturopathy program could achieve remarkable improvements in metabolic health within

six weeks. Similarly, Ashtankar et al. (2024) showed the efficacy of Ayurvedic interventions in reversing prediabetes through non-drug treatments.^[18,19]

These studies highlight the importance of a holistic, integrative approach to managing metabolic disorders, as they address both the physical and mental aspects of the condition. The sustainability of these approaches is another critical factor, as seen in the long-term follow-ups of patients who maintained their health improvements through continued lifestyle modifications.

Mechanisms of action

Ayurvedic treatments for diabetes and its complications target multiple pathways. Its interventions address the root causes of metabolic disorders by focusing on *Agni* (digestive fire) and eliminating *Ama* (toxins). For example, *Phalatrikadi Kwath* aids in reducing *Ama* (toxins) in the body, which is believed to block metabolic pathways, act as an insulin sensitizers, and help detoxify the system, while dietary guidelines emphasize foods that balance the doshas and support metabolic health. Herbs like *Triphala* and *Haridra* (turmeric) also have antioxidant properties, helping to reduce oxidative stress, a key factor in the progression of diabetes and related complications.^[18,19]

In the management of DFU, Ayurvedic procedures such as *Vrana Shodhana* and *Vrana Ropana* promote wound healing by cleansing the ulcer and supporting tissue regeneration. The use of medicated oils and decoctions helps reduce inflammation, control infections, and improve blood circulation to the affected area, thus accelerating the healing process.^[19]

Yoga addresses metabolic syndrome (MetS) by reducing psychological stress, improving metabolic efficiency, and enhancing insulin sensitivity. Asanas (physical postures) stimulates the endocrine system and increase muscle glucose uptake, while pranayama (breathing exercises) and meditation manage stress hormones, reducing the risk of stress-induced metabolic disruptions.^[17]

Naturopathy focuses on detoxification and restoring balance through therapies such as therapeutic fasting,

hydrotherapy, and manipulative treatments. These practices aim to clear metabolic waste and improve overall bodily function. The IYN module's success in managing MetS stems from the synergy between detoxification and stress management, achieved through a combination of diet and yoga practices.

A clinical trial and network pharmacology approach in Ayurveda – Two case studies comparative discussion

A randomized, double-blind, placebo-controlled clinical trial by Chandake *et al.* investigated the effectiveness of *Tryushnadi Churna*, an Ayurvedic herbal formulation, in managing Metabolic Syndrome (MetS) with a specific focus on obesity. Participants diagnosed with MetS based on the National Cholesterol Education Programme (NCEP) Adult Treatment Panel III criteria were included. MetS is a cluster of cardiometabolic conditions, including hypertension, high blood sugar, and abnormal cholesterol levels, often accompanied by obesity. The study highlighted the increasing global prevalence of MetS, particularly in South Asian populations, and the urgent need for multi-targeted therapeutic approaches.^[20]

A study by Dongre *et al.* explored the potential of *Chandraprabha Vati* (CPV), an Ayurvedic formulation containing 37 herbal and mineral components, in managing MetS through a network pharmacology approach. Unlike single-target drugs, CPV is a multi-target formulation, making it suitable for the complex pathology of MetS, which involves inflammation, insulin resistance, and lipid imbalances. The study employed computational tools such as DisGeNET and BindingDB to identify target genes of CPV's components, followed by gene mapping to genes implicated in MetS and inflammation. The researchers used Gene Ontology (GO) enrichment and pathway analysis to understand how CPV bioactives affect pathways linked to metabolism, insulin signaling, and inflammation.^[21]

Comparative discussion based on mechanism of action

Both studies underscore the potential of Ayurvedic formulations in managing Metabolic Syndrome

through a multi-target approach. *Tryushnadi Churna* demonstrated promising results in reducing weight and improving metabolic parameters in a clinical setting, while *Chandraprabha Vati* shows promise at the molecular level through its effects on pathways involved in lipid metabolism, insulin sensitivity, and inflammation.

The major strength of *Chandraprabha Vati* lies in its comprehensive formulation, which can simultaneously address multiple aspects of MetS, including inflammation, glucose metabolism, and oxidative stress. However, its efficacy still needs to be validated in clinical trials. On the other hand, *Tryushnadi Churna* already has demonstrated efficacy in a clinical context, though its mechanisms of action could be further explored using network pharmacology.

One key distinction between the two studies is their methodology. Chandake *et al.* (2024) employed a clinical trial that assessed the tangible effects of *Tryushnadi Churna* in combination with lifestyle interventions, whereas Dongre and Majumdar (2024) utilized a network pharmacology approach to map the molecular interactions of CPV's bioactive. Future research could benefit from integrating these two approaches - clinical trials with molecular analyses - to more comprehensively evaluate the therapeutic potential of Ayurvedic formulations.^[20,21]

DISCUSSION

The holistic approach of Ayurveda in managing T2DM addresses both the symptoms and underlying causes of the disease. By incorporating herbal medicines, detoxification therapies, and lifestyle changes, Ayurveda offers a comprehensive strategy for improving glycemic control, reducing insulin resistance, and preventing complications. Furthermore, the integration of Yoga enhances the effects of dietary and herbal interventions by promoting mental well-being, reducing stress, and improving overall metabolic health.

Despite the growing body of evidence supporting Ayurveda in diabetes management, further clinical research is needed to standardize treatment protocols

and validate the long-term efficacy of these interventions. Large-scale randomized controlled trials will help establish Ayurveda as a complementary therapy in mainstream diabetes care.

Challenges and Future Prospects

While Ayurvedic treatments show promise in managing diabetes and its complications, challenges such as the lack of standardization in herbal formulations and variability in patient response remain. Clinical trials with larger sample sizes are needed to validate the efficacy of integrative treatments. Furthermore, integrating Ayurvedic practices with conventional medicine offers a holistic approach to managing diabetes, but this requires more collaboration between practitioners of both systems.

CONCLUSION

Ayurvedic interventions for T2DM offer a natural, holistic approach to managing diabetes, addressing not only blood sugar levels but also the associated complications. Clinical evidence supports the efficacy of formulations like Ayush-82, PANHEAL, and *Shilajatvadi Lauha* in reducing blood glucose levels and improving insulin sensitivity. These treatments provide a safer alternative to conventional medications, with fewer side effects. Ayurvedic interventions, including polyherbal and herbo-mineral formulations, offer a valuable complementary approach to managing T2DM. As more clinical studies validate the efficacy of Ayurvedic treatments, these natural therapies may serve as viable alternatives or adjuncts to conventional diabetes medications, offering holistic and long-term benefits with fewer side effects and enhanced patient outcomes. Ayurvedic formulations like GlucoCare and holistic interventions that combine *Panchakarma* and Yoga have demonstrated significant improvements in glycemic control, lipid profiles, and overall health. The integration of traditional Ayurvedic knowledge with modern scientific approaches, such as network pharmacology and clinical trials, represents a promising avenue for developing treatments for complex conditions like MetS. Both *Tryushnadi Churna* and *Chandraprabha Vati* demonstrate significant potential, with *Tryushnadi Churna* excelling in weight

management and *Chandraprabha Vati* offering a more comprehensive approach to addressing metabolic imbalances at the molecular level. However, further large-scale studies are needed to validate these findings and promote the integration of Ayurvedic medicine into mainstream diabetes care.

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