International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Role of Multivitamins Sachet in Preventing Nutritional Deficiencies in Body

Vrushali Randive[1], Neha Giramkar[2], Pooja Gondre[3], Sujit Hage[4]

[1,2,3,4]Pdea' Shankarrao Ursal College Of Pharmacy And Research Center, Kharadi, Pune- 411014

ABSTRACT:

Moringa oleifera and chromium picolinate are widely studied natural agents known for their positive impacts on glucose regulation and overall metabolic function. *Moringa oleifera* is recognized for its nutrient density and medicinal uses, offering a rich supply of bioactive polyphenols such as flavonoids, phenolic acids, and glucosinolates. Evidence from systematic reviews reveals that both the leaf and seed extracts, whether prepared with water or organic solvents, consistently reduce blood sugar levels, improve insulin activity, and offer protection against oxidative and lipid-related damage in animal models. Although these benefits are promising, clinical investigations in humans remain limited and varied, highlighting the need for future research with standardized methodologies, precise profiling of bioactive constituents, and specific focus on diabetic and prediabetic groups.

Chromium is an essential micronutrient that improves insulin efficiency while supporting the metabolism of carbohydrates, proteins, and lipids. Insufficient chromium intake is linked to insulin resistance, metabolic syndrome, and elevated cardiovascular risk. Of the different supplement forms, chromium picolinate is considered highly absorbable and effective, and daily intakes of 200–1,000 µg have been shown to enhance glycemic control and reduce insulin resistance in both animal and human studies. Beyond metabolic benefits, chromium picolinate offers antioxidant, anti-inflammatory, and neuroprotective actions and may also support emotional well-being and cognitive performance.[78]

Together, *Moringa oleifera* and chromium picolinate represent valuable, natural options for managing blood sugar, supporting insulin sensitivity, and improving metabolic health. Further research with robust human trials is necessary to confirm their clinical utility, determine optimal dosages, and investigate their potential for combined use in diabetes and related metabolic conditions.

KEYWORDS: *Moringa Oleifera*, Chromium Picolinate, Multivitamin, Diabetes

1. INTRODUCTION:

Diabetes mellitus is a chronic metabolic disorder characterized by high blood glucose levels resulting from the body's inability to produce enough insulin or effectively use the insulin produced. Insulin is a hormone that regulates blood sugar by enabling glucose to enter the body's cells for energy. When this process fails, glucose accumulates in the bloodstream, leading to elevated blood sugar, or hyperglycemia.[85].

The disease is significant because persistent high blood sugar causes serious damage over time to various organs and systems, including the heart, blood vessels, eyes, kidneys, and nerves. Diabetes increases the risk of severe complications such as blindness, kidney failure, cardiovascular disease, stroke, and lower limb amputations. Globally, diabetes affects hundreds of millions of people with rising prevalence,

especially in low- and middle-income countries. Despite its severity, diabetes can be managed and its complications delayed or prevented through a healthy diet, regular physical activity, medication, and ongoing medical care[86].

Understanding diabetes mellitus is vital because it is a major public health challenge responsible for millions of deaths annually and substantial healthcare burdens. Early detection and management improve quality of life and reduce the risk of life-threatening complications. Hence, awareness, treatment access, and lifestyle modifications are key to controlling this global health problem. [86,87].

Table 1: Global Statistics:

Statistic	**Value**	**Description**
Adults living with diabetes (age 20-79)	**589 million**	**Approximately 1 in 9 adults worldwide has diabetes**
Projected adults with diabetes by 2050	**853 million**	**Number expected to rise substantially**
Deaths caused by diabetes in 2024	**3.4 million**	**Equivalent to 1 death every 9 seconds**
Global health expenditure due to diabetes	**USD 1 trillion**	**Represents a 338% increase over the last 17 years**
Percentage living in low- and middle-income countries	**81%**	**The majority of diabetes cases occur in these countries**
Diabetes prevalence in adults (2022)	14%	Increased from 7% in 1990
Percentage of adults with diabetes untreated (2022)	59%	Many adults with diabetes do not receive medication
Deaths from diabetes and kidney disease	Over 2 million (2021)	Leading causes of mortality related to diabetes
Contribution to cardiovascular deaths	11% (high blood glucose related)	High blood sugar contributes to cardiovascular mortality

These figures underscore the growing global burden of diabetes and its impact on health systems worldwide. The disease remains under-treated, especially in low- and middle-income countries, with substantial morbidity, mortality, and economic costs. [88,89].

Table 2: Diabetes Mellitus Mortality based on Age:

Age Group	Mortality Characteristics
Under 30 years	Lower absolute number of deaths, but in Type 1 diabetes, significant premature mortality occurs if untreated.
30 to 70 years	Around 47% of all diabetes-related deaths occur before age 70, indicating a substantial premature mortality.
Over 70 years	Mortality due to diabetes increases with age, contributing to complications like cardiovascular disease, kidney failure, and stroke.

Additional points:

- Diabetes causes 3.4 million deaths globally in 2024, averaging 1 death every 9 seconds.
- Mortality rates have been increasing since 2000, with higher mortality observed in low- and middle-income countries.
- Many deaths occur prematurely, largely due to complications arising from chronic high blood sugar.
- The type of diabetes, treatment availability, and lifestyle factors influence mortality. [88,89].

2 Herbs As a Multivitamin

2.1 Moringa:

Moringa oleifera, widely recognized as the drumstick tree, belongs to the *Moringaceae* family and is noted for its rapid growth and ability to withstand drought. Originally native to the southern Himalayan region and parts of South Asia, it is now grown throughout many tropical and subtropical areas. [82,83]. All parts of this plant—leaves, pods, seeds, and flowers—are edible and appreciated both for their nutritional value and traditional medicinal uses. [81,83].

The leaves, in particular, stand out as a substantial source of nutrients. They pack a high concentration of proteins, vitamins such as β-carotene, vitamin E, folic acid, as well as minerals including iron, calcium, magnesium, and zinc. [83]. The presence of dietary fiber and important fatty acids like omega-3 and omega-6 further enhances its reputation as a food for combating undernutrition. Researchers have identified an array of beneficial phytochemicals within *Moringa oleifera,* such as flavonoids, phenolic acids, alkaloids, glucosinolates, and saponins—each contributing to the plant's antioxidant, anti-inflammatory, heart-protective, and antidiabetic qualities. [74,81,83].

Moringa oleifera's ability to help lower blood sugar is mostly attributed to polyphenols, flavonoids, and glucosinolates present in its leaves, which protect insulin-producing cells in the pancreas, boost insulin sensitivity, and slow glucose absorption. Laboratory studies indicate that extracts can inhibit enzymes like α-amylase and α-glucosidase, easing the rise in blood glucose following meals.

Given its wide nutritional profile and bioactive potential, it is regarded as a promising supplement for regulating blood sugar and helping prevent type 2 diabetes. [82,83]

Type 2 diabetes mellitus (T2DM) is a growing global issue, largely due to insulin resistance and lower insulin output. Managing this condition is challenging, and many patients seek safer, more affordable plant-based interventions. *Moringa oleifera* has been a staple in traditional diets and healing systems,

especially in regions like Thailand and Western Asia. [82 ,83] Studies involving animals consistently report that the leaves can reduce glucose levels in both the blood and urine, while improving tolerance to sugar and slowing down how quickly the stomach empties. In human studies, taking 4 g of *Moringa oleifera* leaf powder was shown to stimulate insulin release without adverse effects in healthy participants. Nonetheless, more research is needed to determine the benefits for individuals with T2DM. [82,83] (review on moringa, 2022)

Elevated blood pressure, or hypertension, is a leading risk factor for cardiovascular disease worldwide. Its prevalence has nearly doubled in recent decades, with a disproportionate burden in developing regions. [83]. Although lifestyle changes can help lower blood pressure, these measures aren't always sufficient or feasible for everyone, creating a need for alternative solutions. In this context, medicinal plants such as *Moringa oleifera* are gaining popularity. The leaves contain not only ample proteins, vitamins, minerals, and fiber, but also compounds that might help with blood pressure control. [82,83] Despite many general reviews on *Moringa oleifera's* diverse health roles, few have summarized its specific effects on hypertension. Preclinical and emerging clinical evidence suggest *Moringa oleifera* could be useful in managing blood pressure, prompting ongoing research into underlying mechanisms and practical applications.[83]

The entire *Moringa oleifera* plant—often called the "miracle tree"—has numerous uses beyond food and medicine. Its adaptability allows cultivation even in poor soils, supporting sustainable farming projects, particularly in regions challenged by malnutrition or environmental degradation. Its leaves, loaded with high-quality protein, essential amino acids, and key vitamins and minerals, are well-suited for food programs, supplements, and fortification of other products. Phytochemicals such as flavonoids, phenolic acids, and glucosinolates add to its wide range of health benefits, which include antioxidant, anti-inflammatory, antimicrobial, antidiabetic, anticancer, and immune-boosting effects. High oleic acid content in the leaves makes them valuable even for cosmetic product formulations. [81,82,83]

Moringa oleifera is being explored for diverse roles: functional food ingredient, herbal remedy, cosmetic raw material, climate-resilient crop, soil regenerator, and carbon sink. The plant's adaptability, nutritional advantage, and ecological impact have made it a focus of multidisciplinary research aimed at optimizing both its practical uses and broader health benefits. [83,84].

When incorporated into food fortification programs, *Moringa oleifera* provides not just vitamins and minerals but also an impressive array of bioactive plant compounds. Different extraction methods—like maceration, Soxhlet extraction, and ultrasound-assisted extraction—can influence the quantity and activity of these phytochemicals, in turn affecting both the nutritional value and taste of enriched foods. [84]

Fig.1- Moringa powder

2.1.1 TAXONOMY OF MORINGA:

Moringa oleifera is a fast-growing, deciduous tree belonging to the genus Moringa within the family *Moringaceae*. It is native to northern India and widely cultivated across tropical and subtropical regions worldwide. [74]

Taxonomical Classification:

Table 3

Kingdom	Plantae
Subkingdom	Tracheobionta (vascular plants)
Superdivision	Spermatophyta (seed plants)
Division	Magnoliophyta (angiosperms or flowering plants)
Class	Magnoliopsida (dicotyledons)
Subclass	Dilleniidae
Order	Capparales (sometimes noted as Brassicales)
Family	*Moringaceae*
Genus	moringa
Species	*Moringa oleifera*

Morphologically, it typically grows between 10 and 12 meters in height with a straight trunk and an open canopy of drooping branches. The leaves are feathery and tripinnate, comprising small leaflets. The tree produces fragrant, hermaphroditic flowers with yellowish-white petals arranged in clusters. The fruit is a distinctive three-sided pod commonly known as the drumstick, which can grow up to 20–45 cm long, containing dark brown seeds with papery wings that facilitate wind dispersal. [84].

Moringa oleifera thrives best in well-drained, loamy to sandy soils with a slightly acidic to alkaline pH. It grows in tropical and subtropical climates with temperatures ranging from 25 to 35 °C. The tree is drought-resistant and is widely used for its nutritious leaves, pods, seeds, and various medicinal applications. [76,83]

2.1.2 Role of Moringa:

- *Moringa oleifera* contains bioactive compounds such as polyphenols, flavonoids, and glucosinolates that help regulate blood glucose by protecting pancreatic cells and enhancing insulin sensitivity. [81,82,83].
- Extracts of *Moringa oleifera* leaves and seeds demonstrate significant hypoglycemic effects by inhibiting carbohydrate-digesting enzymes, reducing post-meal blood sugar spikes. [83].
- Animal studies show *Moringa oleifera* leaf extracts at doses of 100–300 mg/kg for 2–8 weeks improve glycemic control, lipid profiles, and reduce oxidative stress involved in diabetic complications.
- Limited clinical trials in humans reveal that supplementing with about 20 g of *Moringa oleifera* leaf powder for two weeks lowers postprandial blood glucose in prediabetic and diabetic individuals without adverse effects.
- *Moringa oleifera* consumption improves insulin secretion and glucose tolerance, making it a promising natural adjunct for type 2 diabetes management, although larger randomized controlled trials are needed. [81,82,83]

- Apart from antidiabetic effects, *Moringa oleifera* exhibits antioxidant, anti-inflammatory, cardioprotective, and lipid-lowering properties beneficial for diabetes-related metabolic health. [81,82,83]
- *Moringa oleifera's* rich nutritional profile—including proteins, vitamins (A, B-complex, C, E), minerals (iron, calcium, magnesium), essential fatty acids, and dietary fiber—makes it an excellent ingredient for multivitamin formulations targeting metabolic wellness. [82,83]
- Incorporation of *Moringa oleifera* in multivitamins provides a natural source of essential micronutrients and bioactive compounds that synergistically support immune function, reduce oxidative stress, and improve overall metabolic parameters.
- The use of *Moringa oleifera* in multivitamins can also aid malnutrition prevention, addressing nutrient deficiencies common in diabetic populations, thereby promoting holistic health.[84]

2.1.3 PHARMACOLOGICAL ACTIVITY OF MORINGA:

IN DIABETES:

Moringa oleifera helps manage diabetes primarily through its bioactive compounds that influence blood sugar regulation and insulin sensitivity. The leaf extracts contain antioxidants and anti-inflammatory compounds that reduce oxidative stress and inflammation, which are key contributors to diabetes complications. [82,83]. These compounds enhance insulin signaling and improve the body's response to insulin, thus lowering blood glucose levels. Additionally, Moringa extracts inhibit carbohydrate-digesting enzymes like α-amylase and α-glucosidase, which slow glucose absorption in the intestine. It also modulates levels of inflammatory cytokines and proteins such as peroxisome proliferator-activated receptor gamma (PPARγ), aiding in the reduction of hyperglycemia and improving insulin sensitivity. Moringa's antioxidant properties boost intracellular enzymes like catalase, superoxide dismutase, and glutathione, guarding against cellular damage caused by diabetes. [83].

AS MULTIVITAMIN:

Moringa oleifera is considered a natural multivitamin due to its rich content of essential vitamins and minerals. Its leaves provide significant amounts of vitamin A, vitamin C, vitamin B6, riboflavin (B2), calcium, iron, magnesium, and potassium. These nutrients support various bodily functions, including immune health, energy metabolism, and tissue repair. [82,83] The plant also contains antioxidants and phytonutrients, which help in reducing oxidative stress. Because these nutrients occur naturally in Moringa, the body can absorb and utilize them efficiently compared to synthetic supplements. This nutrient density makes Moringa a valuable dietary addition for nutritional support and prevention of deficiencies. [81,83].

In summary, *Moringa oleifera* combats diabetes through antioxidant, anti-inflammatory, and enzyme-inhibiting actions that improve insulin function and blood sugar control, while also serving as a convenient source of multiple essential vitamins and minerals naturally supporting overall health.[83]

Fig.2- Moringa properties

2.2 Amla:

Amla, also known scientifically as *Emblica* officinalis or *Phyllanthus emblica*, is a fruit used extensively in traditional medicine systems, especially Ayurveda, where it is regarded as a vital source of health and longevity benefits.[71,73] The fruit is celebrated not only for its rich vitamin C content—about thirty times more than oranges—but also for housing a variety of bioactive compounds, such as tannins, flavonoids, gallic acid, ellagic acid, alkaloids, and polyphenols, that deliver a broad spectrum of therapeutic effects.[72,73]

Amla has been historically used to address a range of conditions, including colds, fever, digestive issues, liver disorders, cardiac problems, and skin diseases. It acts as a natural diuretic, laxative, liver tonic, and restorative agent, promoting overall metabolism and immune capability. Multiple preclinical studies support its antioxidant, anti-inflammatory, adaptogenic, cardioprotective, gastroprotective, anti-anemia, anti-hypercholesterolemia, neuroprotective, wound healing, hepatoprotective, nephroprotective, and antineoplastic actions. [71,72,73]

Kingdom	Plantae
Phylum (Division)	Tracheophyta
Class	Magnoliopsida (Dicotyledons)
Order	Malpighiales
Family	*Phyllanthaceae*
Genus	Phyllanthus
Species	*Phyllanthus emblica* (synonym: Emblica officinalis)

Fig.3- Amla fruit

2.2.1 Taxonomy of Amla:

Amla is a medium-sized deciduous tree, typically growing between 8 and 18 meters in height. The trunk is light gray and tends to shed bark in thin, flaky layers. Leaves are simple, subsessile, and densely arranged along slender branchlets, often giving the appearance of compound pinnate leaves. The flowers are small and greenish-yellow, with male and female flowers present on the same branch.[73]

2.2.2Taxonomic Classification:

2.2.3 Role of Amla:

In Diabetes:

1. **Lowers Blood Sugar Levels:**Amla helps decrease fasting and postprandial glucose levels due to its chromium content, which improves insulin sensitivity and carbohydrate metabolism.
2. **Promotes Insulin Secretion:** It stimulates pancreatic beta cells, enhancing insulin production and improving glucose utilization in tissues.
3. **R educes Sugar Absorption:** The high fiber in amla slows carbohydrate digestion and glucose absorption, preventing sudden spikes in blood sugar.
4. **Antioxidant Protection:** It's rich in vitamin C and polyphenol content combat oxidative stress and protect pancreatic cells from free radical damage.
5. **Supports Pancreatic Health:** Amla helps prevent inflammation of the pancreas (pancreatitis), maintaining healthy insulin secretion and metabolism.
6. **Improves Lipid Profile:** It reduces triglycerides and LDL cholesterol, helping prevent diabetes-associated cardiovascular complications.
7. **Enhances Metabolic Function:** Regular use supports the breakdown of carbohydrates, fats, and proteins more efficiently, improving energy and metabolism in diabetics.
8. **Lowers Glycemic Load:** Owing to its low glycemic index, it releases glucose more gradually into the bloodstream. [71,72,73].

As Multivitamins:

1. **Rich Natural Source of Vitamin C:** Amla contains one of the highest concentrations of vitamin C, which remains stable even after processing, enhancing immunity and tissue repair.
2. **Contains Essential Micronutrients:** It provides natural doses of vitamin A, vitamin E, iron, and calcium, supporting overall vitality and preventing deficiencies.
3. **Provides Natural Antioxidants:** Contains tannins, flavonoids, and polyphenols that help neutralize free radicals, slow aging, and maintain cell integrity.
4. **Boosts Immunity:** Regular intake enhances resistance against infections and supports white blood cell function.
5. **Improves Digestive Health:** Amla balances stomach acid and supports gut flora, improving nutrient absorption and preventing fatigue associated with vitamin deficiencies.
6. **Enhances Skin and Hair:** The antioxidants and vitamin C promote collagen synthesis, glowing skin, and strong hair growth.
7. **Acts as a Detoxifier:** Amla cleanses the liver, removes toxins, and maintains body pH levels, which supports metabolic balance.
8. **Supports Cardiovascular and Hormonal Health:** Studies show it helps regulate cholesterol levels and hormonal balance naturally, unlike synthetic supplements. [71,72,73].

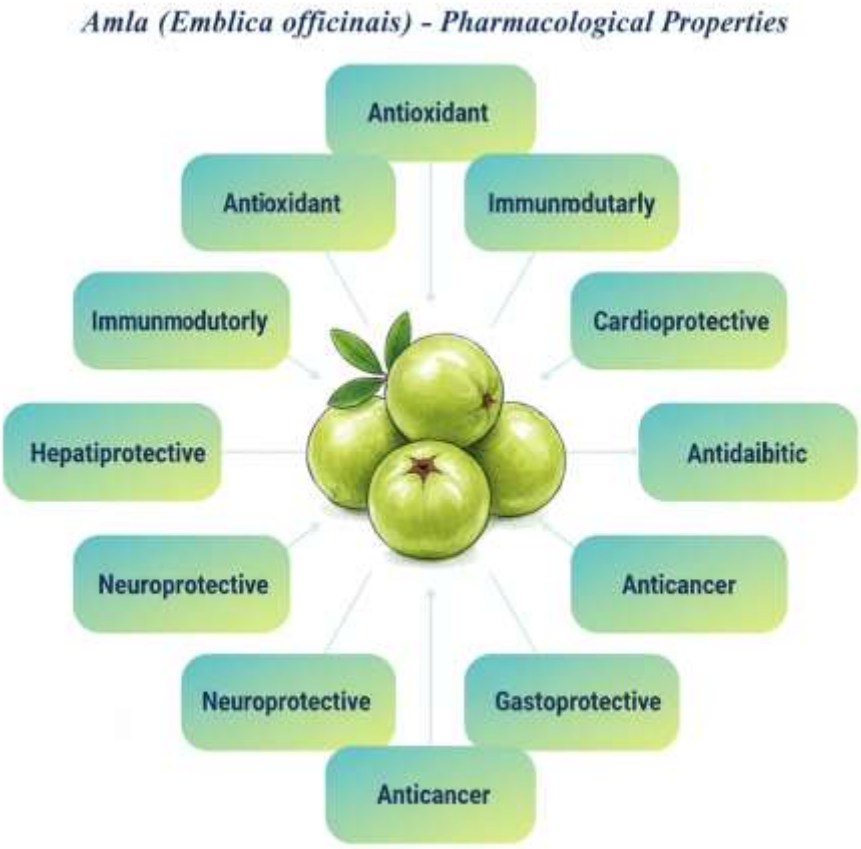

Fig.4- Amla properties

2.3: Chromium

Chromium is an essential trace element that plays an important role in how our bodies use insulin and manage glucose metabolism. Recent research suggests that dietary supplements containing chromium may help improve blood sugar control in people with type 2 diabetes (T2DM) [78,79,80]. Studies have found that chromium deficiency, even at mild levels, can lead to higher blood glucose**,** insulin, and lipid levels, which can make diabetes management more difficult. Interestingly, when chromium levels are restored after a period of deficiency, improvements in blood sugar control have been observed. [78,80]. Chromium works by enhancing insulin signaling through a special compound called the low molecular weight chromium-binding substance. This mechanism increases the sensitivity of insulin receptors on cell membranes, making insulin more effective. As a result, chromium supplementation has been shown in some studies to support better glucose and insulin metabolism in diabetic patients. [78,80]

Chromium (Cr) is a trace mineral that plays an important role in regulating blood sugar levels and improving how the body responds to insulin, making it especially relevant for people with diabetes.[79,80] This element exists in two main forms: the toxic hexavalent chromium and the safer, organic trivalent chromium.[80] Most dietary supplements contain the trivalent form, often bound to picolinic acid to form chromium picolinate. Chromium picolinate is considered less toxic and more bioavailable than other chromium compounds.[79] It's commonly used to help manage conditions related to carbohydrate metabolism, such as insulin resistance and type 2 diabetes (DM2). The dosage of Chromium picolinate can vary widely, typically ranging from 25 µg/kg to 1000 µg/kg. Although only a small portion of chromium is absorbed by the body (about 0.4 to 2.5% of the amount taken), Chromium picolinate shows a higher absorption rate, between 0.7 and 5.2%, compared to other chromium forms. [79,80]

Recently, the dietary supplements, including chromium, were used to manage T2DM and improve glycemic control [28]. Chromium, as an essential element, is found in foods and dietary supplements that play an important role in insulin function and glucose metabolism in mammals [29]. There is evidence that in diabetic patients, subclinical chromium deficiency is associated with elevated blood glucose, insulin, and lipid levels that may adversely affect the management of diabetes [30] and its repletion after experimental dietary depletion led to improvement in glycemic status [31]. Chromium, with the mechanism that expands insulin cell signaling through the low molecular weight chromium-binding substance, increases the sensitivity of insulin receptors in the plasma membrane and improves glycemic control [32]. Some studies have shown that chromium could improve both glucose and insulin metabolism [33]. however, some studies reported no beneficial effect for chromium in T2DM patients [34,35,36]. Given that the content of the human diet is poor in terms of chromium and based on contradictory evidence regarding the effects of chromium, the present study was conducted to evaluate the effects of this supplement on fasting blood glucose (FBG), cholesterol, lipoproteins, insulin, and Insulin resistance in T2DM patients.

2.3.1: TAXONOMY OF CHROMIUM PICOLINATE:

Kingdom: Organic compounds
Superclass: Organoheterocyclic compounds
Class: Pyridines and derivatives
Subclass: Pyridinecarboxylic acids and derivatives **Direct Parent:** Pyridinecarboxylic acids
Synonyms: Chromium(III) picolinate, chromium(III) trispicolinate, chromax
Molecular Formula: C18H12CrN3O6

Molecular Weight: 418.3 g/mol

[41,42,43]

Fig.5 - Chromium Picolinate

2.3.2: Role of Chromium Picolinate

Enhancement of Insulin Action and Glucose Metabolism:

Chromium picolinate functions as a cofactor that enhances insulin activity in the body. It is involved in the formation and activation of chromodulin (previously known as glucose tolerance factor). [47] This low molecular weight chromium-binding substance amplifies insulin receptor signaling on cell membranes.[48] This enhanced insulin signaling facilitates glucose uptake into insulin-sensitive tissues such as skeletal muscle and adipose tissue, thereby improving blood sugar control. [44,45,46]

Lipid Metabolism and Cardiovascular Health

Chromium picolinate plays a beneficial role in lipid metabolism by improving the body's lipid profile.[50] Double-blind, placebo-controlled studies show that chromium picolinate supplementation (200 mcg daily for 42 days) significantly reduces total cholesterol, low-density lipoprotein (LDL) cholesterol, and apolipoprotein B levels while increasing apolipoprotein A-I (the principal protein of HDL) concentrations.[49] These changes in lipid parameters contribute to reduced cardiovascular disease risk.[51]

Aids in Weight Management

Chromium picolinate influences insulin sensitivity and metabolism, potentially aiding fat metabolism and reducing appetite. [52] While not a direct weight-loss supplement, it can support weight management as part of a healthy lifestyle. [53,54]

Safety and Tolerable Intake

According to the European Food Safety Authority (EFSA), chromium picolinate is safe at intake levels not exceeding 250 µg/day. Higher doses may pose health risks, including potential DNA damage in vitro at extreme concentrations.[55]

2.3.3: Pharmacological Activities of Chromium Picolinate

Chromium picolinate is a trivalent chromium complex used as a nutritional supplement to enhance insulin action, regulate glucose homeostasis, and improve lipid metabolism.[56] Its pharmacological effects are

prominent in metabolic, antioxidant, anti-inflammatory, and cardioprotective functions. Below are the major pharmacological activities with verified references and attached links after each point. [57,58]

Regulation of Glucose and Lipid Metabolism

Chromium picolinate significantly improves carbohydrate metabolism by enhancing insulin-induced glucose utilization and glycogen synthesis.[59] Additionally, it supports lipid metabolism by decreasing plasma triglycerides, total cholesterol, and LDL levels while increasing HDL, thus improving cardiovascular profiles in diabetic and obese subjects. [60,61]

Cardioprotective Activity

Studies demonstrate that CrPic offers cardioprotective effects by mitigating doxorubicin-induced myocardial injury, decreasing serum cardiac biomarkers (e.g., troponin I, LDH, CK-MB), and restoring normal cardiac enzyme levels. [62,63] It enhances nitric oxide-mediated vasorelaxation and reduces lipid peroxidation, thus improving heart function and circulation.[64]

Immunomodulatory and Hematological Effects

Chromium picolinate affects immune cytokine expression, including IL-2 and TNF-α, and modulates cellular immunity. It may alter white blood cell parameters under specific conditions, indicating an influence on both humoral and cell-mediated immunity. [66,67]

Safety and Toxicological Profile

Animal studies confirm that chromium picolinate is safe at moderate doses (≤250 µg/day equivalent). High doses cause hepatic and renal alterations, oxidative DNA damage, and histopathological changes in experimental rats. Therefore, careful dose selection is essential in therapeutic applications. [68,69]

3. CONCLUSION:

Herbal drugs like Moringa and Amla have shown promising potential as complementary therapies in diabetes management due to their rich antioxidant content and ability to improve glucose metabolism. Moringa's bioactive compounds contribute to reducing blood sugar levels and enhancing insulin sensitivity, while Amla is valued for its role in lowering oxidative stress and supporting pancreatic function. When combined with multivitamins, these natural agents may help address nutritional deficiencies often observed in diabetic patients, improving overall health and potentially mitigating complications. However, while encouraging, the use of these herbal remedies should be approached cautiously and backed by rigorous clinical studies to establish standardized dosages and ensure safety. Integrating herbal drugs with conventional treatment could offer a holistic approach for managing diabetes, but more research is needed to confirm their long-term efficacy and safety. This underscores the importance of evidence-based application in clinical practice for final-year research and healthcare advancement.

REFERENCE:

1. Kumar, A., et al. "Exploring the Efficacy of Herbal Antidiabetic Preparations." International Journal of Clinical Endocrinology & Metabolism, 2025. Link
2. Singh, R., et al. "Efficacy and Safety of an Ayurveda Herbal Formulation in Diabetes." PMC, 2025. Link
3. Patel, S., et al. "Evaluation of Polyherbal Synergy against Diabetes: In-vitro Study." PMC, 2025. Link
4. Sharma, M., et al. "Developing Nanocarrier-Based Formulations of Antidiabetic Drugs from Medicinal Plants: A Systematic Review." Trends in Pharmacological Sciences, 2024. Link

5. Rao, P., et al. "A Review of Medicinal Plants with Potential Antidiabetic Effect." Plants Journal, 2025. Link
6. Gupta, V., "Studies on Antidiabetic Herbal Formulations Available in the Market." Journal of Pharmacy Research, 2025. Link
7. Malhotra, S., et al. "The Potential of Various Herbal Plants for Therapeutic Treatment for Diabetes Management." NAMS Annals, 2025. Link
8. National Institutes of Health, "Multivitamin/Mineral Supplements - Health Professional Fact Sheet," 2025. Link
9. Verma, N., et al. "Antidiabetic Herbal Drugs and Polyherbal Formulation: A Review." Phytopharmacology Journal, 2025. Link
10. Joshi, R., et al. "A Review on Potential Anti-Diabetic Herbs and Polyherbal Formulations." Indian Journal of Pharmacology and Pharmacotherapeutics, 2025. Link
11. Ahmed, F., et al. "An Overview of Herbal-Based Antidiabetic Drug Delivery Systems." PMC, 2022. Link
12. Kumar, V., et al. "Interaction between Anti-Diabetic Drugs and Herbs: A Review." Pharmacognosy Research, 2021. Link
13. Prakash, D., et al. "Indian Herbs and Herbal Drugs Used for the Treatment of Diabetes." PMC, 2007. Link
14. Uti, D. E., Atangwho, I. J., et al. "Natural Antidiabetic Agents: Current Evidence and Development Pathways." Nutrition and Diabetes, 2025. Link
15. Singh, P., et al. "Review on Conventional as Well as Herbal Approach for Treatment of Diabetes Mellitus." Journal of Diabetes Research, 2025. Link
16. Harvard T.H. Chan School of Public Health, "Best Multivitamins for 2025." Link
17. Bernstein, J., "Best Multivitamins and Minerals 2025 – Tried and Tested." BBC Good Food, 2025. Link
18. Pretty Organic Girl, "The Best Organic Multivitamin Reviews 2025." Link
19. Fortune Magazine, "Best Multivitamins (2025): Tested and Approved by Experts." Link
20. Frontiers in Pharmacology, "Common Ayurvedic, Chinese Traditional and Unani Medicines in Diabetes." 2022. Link
21. https://share.google/images/VX6xJvPwdPrG3pM6d
22. https://media.istockphoto.com/id/1172617465/photo/moringa-powder.jpg?s=612x612&w=0&k=20&c=PU-sutLbpYH8WW__OgeJIVy7R6YCR03mrAZaUjUeRBY=
23. Clinical studies on chromium picolinate supplementation in diabetes mellitus—a review. Diabetes Technology & Therapeutics. 2006 Dec;8(6):677–687.
PMID: (https://pubmed.ncbi.nlm.nih.gov/17109600/)
24. Broadhurst CL, Domenico P. Clinical studies on chromium picolinate supplementation in diabetes mellitus—a review. *Diabetes Technol Ther.* 2006 Dec;8(6):677-87.
PMID: (https://pubmed.ncbi.nlm.nih.gov/17109600/)
25. Vincent JB. A scientific review: the role of chromium in insulin resistance. *J Nutr Biochem.* 2003 Dec;14(12):685-91.
PMID: (https://pubmed.ncbi.nlm.nih.gov/15208835/)

26. Vincent JB. A scientific review: the role of chromium in insulin resistance. *J Nutr Biochem.* 2003 Dec;14(12):685-91.
PMID: (https://pubmed.ncbi.nlm.nih.gov/15208835/)
27. Wang ZQ, Yu Y, Zhang XH, Komorowski J. Chromium–insulin reduces insulin clearance and enhances insulin signaling by suppressing hepatic insulin-degrading enzyme and proteasome protein expression in KKAy mice. *Front Endocrinol (Lausanne).* 2014 Jul 6;5:99.
PMCID: PMC408771
28. Hua Y, Clark S, Ren J, Sreejayan N. Molecular mechanisms of chromium in alleviating insulin resistance. J Nutr Biochem. 2012;23:313–319. doi: 10.1016/j.jnutbio.2011.11.001. [DOI] [PMC free article] [PubMed] [Google Scholar]
29. Sharma S, Agrawal RP, Choudhary M, Jain S, Goyal S, Agarwal V. Beneficial effect of chromium supplementation on glucose, HbA1C and lipid variables in individuals with newly onset type-2 diabetes. J Trace Elem Med Biol. 2011;25:149–153. doi: 10.1016/j.jtemb.2011.03.003. [DOI] [PubMed] [Google Scholar]
30. Rajpathak S, Rimm EB, Li T, Morris JS, Stampfer MJ, Willett WC, Hu FB. Lower toenail chromium in men with diabetes and cardiovascular disease compared with healthy men. Diabetes Care. 2004;27:2211–2216. doi: 10.2337/diacare.27.9.2211. [DOI] [PubMed] [Google Scholar]
31. Anderson RA, Polansky MM, Bryden NA, Canary JJ. Supplemental-chromium effects on glucose, insulin, glucagon, and urinary chromium losses in subjects consuming controlled low-chromium diets. Am J Clin Nutr. 1991;54:909–916. doi: 10.1093/ajcn/54.5.909. [DOI] [PubMed] [Google Scholar]
32. Anderson RA, Polansky MM, Bryden NA, Canary JJ. Supplemental-chromium effects on glucose, insulin, glucagon, and urinary chromium losses in subjects consuming controlled low-chromium diets. Am J Clin Nutr. 1991;54:909–916. doi: 10.1093/ajcn/54.5.909. [DOI] [PubMed] [Google Scholar]
33. 10.Cefalu WT, Hu FB. Role of chromium in human health and in diabetes. Diabetes Care. 2004;27:2741–2751. doi: 10.2337/diacare.27.11.2741. [DOI] [PubMed] [Google Scholar]
34. 11.Kleefstra N, Houweling ST, Bakker SJ, Verhoeven S, Gans RO, Meyboom-de Jong B, Bilo HJ. Chromium treatment has no effect in patients with type 2 diabetes in a Western population: a randomized, double-blind, placebo-controlled trial. Diabetes Care. 2007;30:1092–1096. doi: 10.2337/dc06-2192. [DOI] [PubMed] [Google Scholar]
35. 12.Kleefstra N, Houweling ST, Jansman FG, Groenier KH, Gans RO, Meyboom-de Jong B, Bakker SJ, Bilo HJ. Chromium treatment has no effect in patients with poorly controlled, insulin-treated type 2 diabetes in an obese Western population: a randomized, double-blind, placebo-controlled trial. Diabetes Care. 2006;29:521–525. doi: 10.2337/diacare.29.03.06.dc05-1453. [DOI] [PubMed] [Google Scholar]
36. 13.San Mauro-Martin I, Ruiz-León AM, Camina-Martín MA, Garicano-Vilar E, Collado-Yurrita L, Mateo-Silleras B, Redondo Del Río MP. Chromium supplementation in patients with type 2 diabetes and high risk of type 2 diabetes: a meta-analysis of randomized controlled trials. Nutr Hosp. 2016;33:27. doi: 10.20960/nh.v33i1.27. [DOI] [PubMed] [Google Scholar]
37. DrugBank: Chromium picolinate compound classification
https://go.drugbank.com/drugs/DB11255
38. PubChem: Chromium(III) picolinate chemical details
https://pubchem.ncbi.nlm.nih.gov/compound/Chromium_III_-picolinate

39. Wikipedia: Chromium(III) picolinate properties and structure https://en.wikipedia.org/wiki/Chromium(III)_picolinate[3]
40. NCBI Bookshelf: Chromium Picolinate Prototype Monograph https://www.ncbi.nlm.nih.gov/books/NBK216043/
41. DrugBank Accession Number DB11255 - Chemical Taxonomy (Provided by Classyfire) https://go.drugbank.com/drugs/DB11255
42. Chromium(III) picolinate, PubChem CID: 151932 https://pubchem.ncbi.nlm.nih.gov/compound/Chromium_III_-picolinate
43. Chromium(III) picolinate chemical properties and classification https://supremepharmatech.com/en/process/ingredient-database/chromium-3-picolinate.html
44. Chromium Picolinate for Diabetes: Blood Sugar Control and Benefits https://healthinkwell.com/chromium-picolinate-for-diabetes/
45. Molecular Mechanisms of Chromium in Alleviating Insulin Resistance https://pmc.ncbi.nlm.nih.gov/articles/PMC3308119/
46. Effects of Chromium Picolinate Supplementation on Control of Metabolic Variables: https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=0133362f5d3c88350678b1de07d516bf5a057655
47. Havel PJ. A scientific review: the role of chromium in insulin resistance. *Diabetes* Educ. 2004;30(Suppl):2-14. PMID: (https://pubmed.ncbi.nlm.nih.gov/15208835/)
48. Broadhurst CL, Domenico P. Clinical studies on chromium picolinate supplementation in diabetes mellitus—a review. *Diabetes Technol Ther.* 2006;8(6):677-687. PMID: (https://pubmed.ncbi.nlm.nih.gov/17109600/)
49. The effect of chromium picolinate on serum cholesterol and apolipoprotein fractions in human subjects https://pubmed.ncbi.nlm.nih.gov/2408233/
50. Broadhurst CL, Domenico P. Clinical studies on chromium picolinate supplementation in diabetes mellitus—a review. *Diabetes Technol Ther.* 2006;8(6):677-687. PMID: (https://pubmed.ncbi.nlm.nih.gov/17109600/)
51. Martin J, Wang ZQ, Zhang XH, et al. Chromium picolinate supplementation attenuates body weight gain and increases insulin sensitivity in subjects with type 2 diabetes. Diabetes Care. 2006;29(8):1826-1832. https://diabetesjournals.org/care/article/29/8/1826/28698/
52. Effects of chromium supplementation on body composition in patients with type 2 diabetes: A dose-response systematic review and meta-analysis of randomized controlled trials https://www.sciencedirect.com/science/article/abs/pii/S0946672X23002146
53. https://healthyhey.com/blogs/best-supplements-blog/chromium-picolinate-a-comprehensive-guide-to-benefits-dosage-and-safety-in-2025
54. https://www.health.com/chromium-picolinate-benefits-8653725
55. Scientific Opinion on the safety of chromium picolinate as a source of chromium added for nutritional purposes to foodstuff for particular nutritional uses and to foods intended for the general population https://www.efsa.europa.eu/en/efsajournal/pub/1883

56. Oral Chromium Picolinate Improves Carbohydrate and Lipid Metabolism and Enhances Skeletal Muscle Glut-4 Translocation in Obese, Hyperinsulinemic (JCR-LA Corpulent) Rats https://www.sciencedirect.com/science/article/pii/S0022316622151126
57. https://ijpp.org.in/archive/volume/3/issue/1/article/23107/pdf
58. https://healthyhey.com/blogs/best-supplements-blog/chromium-picolinate-a-comprehensive-guide-to-benefits-dosage-and-safety-in-2025
59. Effects of chronic chromium picolinate treatment in uninephrectomized rat https://pubmed.ncbi.nlm.nih.gov/16125537/
60. https://ods.od.nih.gov/factsheets/Chromium-HealthProfessional/
61. https://dergipark.org.tr/en/download/article-file/5022088
62. Cytotoxicity and Antimicrobial Activity of Chromium Picolinate Mediated Zinc Oxide Nanoparticle https://journaljpri.com/index.php/JPRI/article/view/1579
63. https://ods.od.nih.gov/factsheets/Chromium-HealthProfessional/
64. A Comprehensive Review of the Impact of Chromium Picolinate on Testicular Steroidogenesis and Antioxidant Balance https://pmc.ncbi.nlm.nih.gov/articles/PMC10451325/
65. Effects of Different Chromium Compounds on Hematology and Inflammatory Cytokines in Rats Fed High-Fat Diet https://pmc.ncbi.nlm.nih.gov/articles/PMC7953491/
66. https://www.frontiersin.org/journals/immunology/articles/10.3389/fimmu.2021.614000/pd
67. Safety evaluation of chromium picolinate in experimental rats https://www.ijbcp.com/index.php/ijbcp/article/view/3773
68. Opinion controversy to chromium picolinate therapy's safety and efficacy: ignoring 'anecdotes' of case reports or recognising individual risks and new guidelines urgency to introduce innovation by predictive diagnostics? https://pmc.ncbi.nlm.nih.gov/articles/PMC3515400/
69. Effects of chromium supplementation on body composition in patients with type 2 diabetes: A dose-response systematic review and meta-analysis of randomized controlled trials https://www.sciencedirect.com/science/article/abs/pii/S0946672X23002146
70. Functional and Nutraceutical Significance of Amla (Phyllanthus emblica L.): A Review Maryam Gul,Zhi-Wei Liu , Iahtisham-Ul-Haq , Roshina Rabail , Fatima Faheem , Noman Walayat , Asad Nawaz , Muhammad Asim Shabbir ,, Paulo E S Munekata , José M Lorenzo , Rana Muhammad Aadil ,Editors: Jicheng Zhan, Zhigang Liu, Hui-Min David Wang
71. Amla (Emblica officinalis): Role in health management via controlling various biological activities,Author links open overlay panelSaleh A. Almatroodi a, Mohammed A. Alsahli a, Ahmad Almatroudi a, Kapil Dev b, Sahar Rafat b, Amit Kumar Verma b, Arshad Husain Rahmani
72. A REVIEW ON :-MEDICINAL USE OF "AMLA".May 2021.Authors:Ishwar Chandra Chaurasiya,Shashikant Maury,Piyush Yadav,Kumar Yadav
73. Moringa oleifera Lam.: A Nutritional Powerhouse with Multifaceted Pharmacological and Functional Applications.Natalina Panova , Anelia Gerasimova , Galia Gentscheva , Stoyanka Nikolova 4, Lubomir Makedonski , Margarita Velikova , Abdessamad Beraich , Abdelmonaem Talhaoui , Nadezhda Petkova , Daniela Batovska , Krastena Nikolova
74. Environmental, industrial, and health benefits of Moringa oleifera Harshika Mahaveerchand . Abdul Ajees Abdul Salam

75. Moringa oleifera: A Review of the Pharmacology, Chemical Constituents, and Application for Dental Health by Meiny Faudah Amin ,ORCID,Taufiq Ariwibowo ,Salsabila Aqila Putri ORCID and Dikdik Kurnia
76. Effects of Chromium Picolinate Supplementation on Control of Metabolic Variables: A Systematic Review ,Bruna Marmett, Ramiro Barcos Nune
77. Effects of Chromium Picolinate Supplementation on Cardiometabolic Biomarkers in Patients with Type 2 Diabetes Mellitus: a Randomized Clinical Trial Aria Tavakoli Talab , Hadi Abdollahzad , Seyyed Mustafa Nachvak , Yahya Pasdar , Shahryar Eghtesadi , Azimeh Izadi , Mir Amir Aghdashi , Mohammad Reza Mohammad Hossseini Azar , Sedighe Moradi , Behzad Mehaki , Shima Moradi
78. Effects of Chromium Picolinate Supplementation on Control of Metabolic Variables: A Systematic Review ,Bruna Marmett, Ramiro Barcos Nunes
79. Chromium – a scoping review for Nordic Nutrition /Recommendations 2023 ,Christine Henriksen and Susanne Bügel
80. *Moringa oleifera*: An Updated Comprehensive Review of Its Pharmacological Activities, Ethnomedicinal, Phytopharmaceutical Formulation, Clinical, Phytochemical, and Toxicological Aspects Ashutosh Pareek , Malvika Pant , Madan Mohan Gupta , Pushpa Kashania , Yashumati Ratan , Vivek Jain , Aaushi Pareek , Anil A Chuturgoon.Editor: Debasish Bandyopadhyay
81. Moringa oleifera: A review on nutritive importance and its medicinal applicationAuthor links open overlay panelLakshmipriya Gopalakrishnan b, Kruthi Doriya a, Devarai Santhosh Kumar
82. A comprehensive review on *Moringa oleifera* nanoparticles: importance of polyphenols in nanoparticle synthesis, nanoparticle efficacy and their applicationsHaribalan Perumalsamy, Sri Renukadevi Balusamy, Johan Sukweenadhi, Sagnik Nag, Davoodbasha MubarakAli, Mohamed El-Agamy Farh, Hari Vijay &Shadi Rahimi .*Journal of Nanobiotechnology* volume 22, Article number: 71 (2024)
83. A review on extraction technique and immune-boosting properties of *Moringa oleifera* Lam Ifra Tariq,Adeela Yasmin**,**Ali Imran,Hassnain Akhtar,Muhammad Afzaal,Muhammad Azeem,Ruby Pant,Junaid Abid,**Fakhar Islam,**Tahir Zahoor &**Abdela Befa Kinkie**
84. Global, regional, and national burden of diabetes from 1990 to 2021, with projections of prevalence to 2050: a systematic analysis for the Global Burden of Disease Study 2021
85. Prevalence of Diabetes in India: A Review of IDF Diabetes Atlas 10th Edition
86. IDF Diabetes Atlas: Global, regional and country-level diabetes prevalence estimates for 2021 and projections for 2045
87. Global, regional, and national burden of diabetes from 1990 to 2021, with projections of prevalence to 2050: a systematic analysis for the Global Burden of Disease Study 2021
88. Diabetes and all-cause mortality among middle-aged and older adults in China, England, Mexico, rural South Africa, and the United States: A population-based study of longitudinal aging cohorts