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Systematic Review: The Efficacy of Coriander, Cinnamon, Fenugreek, and Flaxseed, in Regulating Blood Sugar

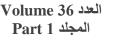
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Abstract

Worldwide, the incidence of type 2 diabetes in children and young adults is rising quickly, which is concerning because it is increasing the burden of childhood obesity. The illness is linked to many risk factors, some of which are hereditary and some of which are lifestyle-related. Since poorly treated diabetes can lead to the formation of related comorbidities and current drugs frequently induce undesired side effects, there is an urgent need to discover new therapies for the prevention and management of this complicated disorder. Compounds obtained from nature are becoming more popular for treating and preventing several complex diseases, such as type 2 diabetes. This systematic review paper aims to discuss the effects of four bioactive herbs, such as coriander, cinnamon, fenugreek, and flaxseed as a therapeutic for pre-diabetes and diabetes type 2 treatment. In addition, it reviews their dosage, mechanisms, and clinical efficacy in blood sugar regulation. As a result, various studies showed that using certain amounts of these herbs changed the glucose level of diabetic patients.

Keywords: blood glucose, flax seed, coriander, fenugreek, cinnamon, diabetes.





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مراجعة منهجية: فعالية الكزبرة والقرفة والحلبة وبذور الكتان في تنظيم سكر الدم

> جنان مختار أبوغرسة جامعة مصراتة - ليبيا

> > الملخص

في جميع أنحاء العالم، يرتفع معدل الإصابة بمرض السكري من النوع 2 بين الأطفال والشباب بسرعة، وهو أمر مثير للقلق لأنه يزيد من عبء السمنة لدى الأطفال. يرتبط والشباب بسرعة، وهو أمر مثير للقلق لأنه يزيد من عبء السمنة لدى الأطفال. يرتبط المرض بالعديد من عوامل الخطر، بعضها وراثي وبعضها مرتبط بأسلوب الحياة. نظرًا لأن مرض السكري الذي يتم علاجه بشكل سيئ يمكن أن يؤدي إلى تكوين أمراض مصاحبة ذات صلة وأن الأدوية الحالية تسبب في كثير من الأحيان آثارًا جانبية غير مرغوب فيها، فهناك حاجة ملحة لاكتشاف علاجات جديدة للوقاية من هذا الاصطراب المعقد وإدارته. أصرخ المعقد وإدارته. أصبحت المركبات التي يتم الحصول عليها من الطبيعة أكثر شيوعًا لعلاج والوقاية من النادع 2. تهدف ورقة المواقاية من النوع 2. تهدف ورقة المواقاية من النوع 2. تهدف ولية المراجعة المنهجية هذه إلى مناقشة تأثيرات أربعة أعشاب نشطة بيولوجيًا، مثل فعالية من النوع 2. بالإضافة إلى ذلك، تستعرض جرعتها وآلياتها وفعاليتها السكري وعلاج مرض السكري من النوع 2. بالإضافة إلى ذلك، تستعرض جرعتها وآلياتها وفعاليتها السكري من النوع 2. بالإصافة إلى ذلك، تستعرض جرعتها وآلياتها وفعاليتها السكري وعلاج مرض المركري من النوع 2. بالإمان المراجعة المنهجية هذه إلى مناقشة تأثيرات أربعة أعشاب نشطة بيولوجيًا، مثل فعالية من النوع 2. بالإضافة إلى ذلك، تستعرض جرعتها وآلياتها وفعاليتها السريرية في تنظيم من النوع 2. بالإضافة إلى ذلك، تستعرض المرحلة ما قبل السكري وعلاج مرض السكري من النوع 2. بالإضافة إلى ذلك، تستعرض المرحلة ما قبل السكري وعلاج مرض السكري الكربرة والذي وعلاج مرض السكري الكربرة والنوع 2. بالإضافة إلى ذلك، تستعرض المرحلة ما قبل السكري وعلاج مرض السكري الكربرة مانوع 2. بالإضافة إلى ذلك، تستعرض المرحلة ما قبل السكري وغايتها السريرية في تنظيم ما النوع 2. بالإضافة إلى ذلك، تستعرض المرحلة ما والواتها وفعاليتها السريرية من هذه من النوع 2. بالإضافة إلى ذلك، تستعرض المرحلة ما قبل السكري وغايته مينة من هذه من النوع 2. بالإضافة إلى ذلك، تستعرض المرحلة ما مرحلة ما قبل السكري ما السكري الم مرض السكري الم ما المكري الم ما السكري الم م النوى الخوى الخوى الخائية أولون النوع 2. بالإضافة إلى ذلك، تستعرض المرحانه أولون الك، مرحلة مرحلتها مرحلة ما مرل الم مالع ما المكري الم م الم م المري الكم الم مالله ما مر مر

Introduction

Insulin resistance, reduced sensitivity to insulin, and insufficient insulin release by the pancreatic islets' β -cells are the hallmarks of type 2 diabetes mellitus (T2DM). Patients with this condition progressively raise their postprandial and fasting blood glucose levels; yet, one of the first harmful processes that starts decades before type 2 diabetes occurs is the reduction in insulin sensitivity (Roden & Shulman, 2019). An individual with prediabetes has a higher blood glucose level than usual, decreased glucose tolerance, and an increased risk of developing diabetes. On the other hand, pancreatic beta cells are destroyed by the immune system in type 1 diabetes, which results in decreased insulin generation (WHO,

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2006). There is an increased risk of developing microvascular and macrovascular problems in individuals with type 2 diabetes and prediabetes (Carris *et al.*, 2019). Metformin, sulfonylureas, thiazolidinediones, dipeptidyl peptidase-4 inhibitors, agonists of the glucagon-like peptide-1 (GLP-1) receptor, inhibitors of the sodium-glucose cotransporter-2 (SGLT2), and insulin therapy are among the drugs that are frequently administered. The main goals of these drugs are to increase insulin sensitivity, lower the amount of glucose produced by the liver, increase insulin secretion, or make it easier for peripheral tissues to absorb glucose. However, many medicines that are now administered have negative effects, cost a lot of money, lose their effectiveness over time, and can conflict with other prescriptions (Galindo *et al.*, 2023). Thus, there is a need for more effective therapies and prophylactic measures to control glucose levels.

Bioactive substances that come from natural sources, like plants, animals, minerals, and microorganisms, are called natural compounds. Natural items have been used as traditional medicines worldwide for millennia, with more than 80% of people depending on them to heal ailments (Wangchuk, 2018). Many natural substances have demonstrated potential in treating type 2 diabetes (Terry, 2020). Several studies indicated a variety of traditional herbs elicited beneficial effects on controlling diabetes, such as flaxseeds, coriander, fenugreek, and cinnamon (Hutchins *et al.*, 2013, Ruban & Nandhini, 2020, Zargar, 1992, Zahedifar *et al.*, 2018). Therefore, concentrating on safe and efficient methods of avoiding the progression of prediabetes to diabetes could lower the burden on the health system.

Methods

This study employed an inductive qualitative methodology and published materials, including peer-reviewed journals focusing on clinical trials, systematic reviews, and meta-analyses about the efficacy of coriander, cinnamon, fenugreek, and flax seed in regulating blood sugar. Science Direct, PubMed, SCOPUS, and Google Scholar were used as sources of information that were searched up to 2024.

Results and discussion

This study includes 61 studies on diabetics varied in sample sizes, intervention durations, and measured outcomes. The primary findings for each herb are summarized below:

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Coriander

Coriander is scientifically named Coriandrum sativum (Velázquez et al., 2023) (fig. 1), which is one of the most often used spices, it is also generally available, has therapeutic and nutritional qualities, ais mostly grown for its seeds, harvested for its essential oil and monoterpenoid, linalool (Rajeshwari & Andallu, 2011). It merits more clinical research on the use of its phytochemicals in treating illnesses since it has the potential to become a prominent plant source of therapeutic compounds. It is strongly advised to use it to achieve herbal cures for ailments and treat nutrient deficiencies because of its safe profile (Banerjee et al., 2024) This herb is also well-known around the world due to its culinary, medical, and applications. Numerous phytochemicals, dietary including polyphenols, reducing sugars, terpenoids, carotenoids, glycosides, sterols, isocoumarins, flavonoids, tannins, alkaloids, fatty acids, and coumarins, can be found in it (Asghar, 2024). As a result, the consumption of coriander was found to be an effective method of maintaining the blood glucose level among pre-diabetic clients (Anjana, 2011), table (1).



Figure (1). Coriander (Yeung, & Bowra, 2011)

Over 14 days, a study tested the hypoglycemic effects of *Coriandrum sativum* (coriander) in 10 patients with type 2 diabetes who take oral hypoglycemic agents with inadequate control, and 6 control subjects were given low (2.5 g /day) and high (4.5 g /day) doses of *Coriandrum sativum* powdered part, aqueous extract, and alcoholic extract after fasting plasma and urinary glucose tests.

On the 15th day, blood and urine samples for glucose were collected. *Coriandrum sativum* has strong hypoglycemic activity at large doses and can be successfully taken with oral hypoglycemic medicines in type-2 diabetic patients who are not controlled by these



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medications (Akbar & Munir, 2006). Furthermore, a clinical trial indicated that coriander seed intake (1000 mg/day) lowered Fasting Blood Sugar (FBS) from 156.15 mg/dl to 130.30 mg/dl, serum (17.72 ± 0.47) to 17.12±0.76), Homeostasis Model insulin Assessment of Insulin Resistance (HOMA-IR) (6.82±0.95 to 5.52±0.99) after six weeks (Zamany et al., 2022). A study found that coriandrum sativum L. oil has antioxidant activity as well as the ability to improve kidney and pancreatic pathological abnormalities caused by diabetes (El-Soud et al., 2012). A research evaluated coriander seed powder's efficiency in lowering blood sugar levels among pre-diabetic individuals, and found a significant decrease from a pretest mean of 119.65 to a post-test mean of 111.92, with a paired'test value of 10.950. (Ruban, 2020). Another study found that all subjects had a mean (FBS) of 189.4 ± 51.05 mg/dl and an average (HbA1C) of 9.2 \pm 1.42 percent. There was no significant difference between the coriander and placebo groups (Zahmatkesh & Khodashenas, 2013). Therefore, coriander has considerable efficacy hypoglycemic at lower doses and antioxidant characteristics, however, its effects on (HbA1c) require additional investigation, table (5, 6).

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Author & Year	Bioactive	Effects
	components	
(Iqbal et al., 2019)		-It has antioxidant capabilities
		to minimize oxidative stress
(Dhakshayani & Priya,	phenols and	and enhance glucose
2022)	flavonoids	metabolism.
(Asghar, 2024)		- It enhances α-amylase enzyme
		inhibition, contributing to their
		antidiabetic potential.
(Zambelli, 2024)		- They have been connected to
	Linalool and	anti-inflammatory properties,
(Rajeshwari &	petroselinic	which help blood sugar
Andallu, 2011)	acid	management.
(Iqbal et al., 2019).		
(Iqbal et al., 2019)	lipid and	- It has significant
	essential oil	hypoglycemia.
	content	

Table (1) Effects of bioactive components of coriander on blood sugar and metabolic markers



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Cinnamon

The bio name of cinnamon is Cinnamomum verum (or Cinnamomum zevlanicum) (Velázquez et al., 2023) (fig. 2), which is conventional herbs and spices frequently used to regulate blood sugar, with cinnamon having the most impact. Cinnamon has been found in studies to help reduce blood sugar levels that have similar effects on insulin action (Hlebowicz et al., 2007)Numerous investigations have been carried out to validate the impact of cinnamon on lowering blood glucose levels in individuals with diabetes (Gheibi et al., 2024). According to in vitro research, cinnamon extract exhibits insulin-like qualities by enhancing the phosphorylation activity of insulin receptors and lowering tyrosine phosphatase activity (Olefsky, 2000). According to certain research, cinnamon suppresses the action of glycogen synthase just the way insulin hormone does (Jarvill-Taylor et al., 2001). Hence, using cinnamon for type II diabetes patients can be recommended, table (2).



Figure (2). Cinnamon (Newerli-Guz, & Śmiechowska, 2022)

A study showed diabetic patients who took cinnamon for four weeks, their mean fasting blood glucose level fell to 126.67 mg/dl, triglycerides (150 mg/dl). The drop in mean fasting blood glucose level was significant (P < 0.001) (Al Jamal, 2009). Moreover, cinnamon at 250 mg twice a day decreased blood glucose with mean difference (MD) = -0.25 (95% Confidence Interval (CI) = -0.36 to -0.14; p<0.00001), while 2 g three times a day had MD = -5.60 (95%CI = -6.98 to -4.22; p<0.00001). (Antônio *et al.*, 2021). Cinnamon supplementation (5 g/day for eight weeks) demonstrated significant health advantages both in vitro and in vivo, suggesting its potential as a natural herbal medicine (Aldaye, 2016). Meta-analysis of 28 Randomized Controlled Trials (RCTs) with durations ranging from 30 to 120 days with a total enrollment of 3054 DM2 patients. Participants consuming cinnamon showed a significant



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reduction in (FBG) Weighted Mean Difference (WMD: -15.26 mg/dL; 95% CI: -22.23 to -8.30; I2 = 88%), postprandial glucose (WMD: -39.22 mg/dL; (Confidence Interval) 95% CI: -63.90 to -14.55; I2 = 100%), Hemoglobin A1c (HbA1c) (WMD: -0.56 mg/dL; 95% CI: -0.99 to -0.13; I2 = 94%), and HOMA-IR (WMD = -0.76, 95% CI: -1.13 to -0.39; I2 = 22%) compared with the control group. An intervention of cinnamon in capsule form reduced (FBG) (WMD:-18.43 mg/dL, 95% CI: -26.32 to -10.53; I2 = 89%), postprandial glucose (WMD: -44.83 mg/dL, 95% CI: -70.67 to -18.99; I2 = 100%), (HbA1c) (WMD: -0.56 mg/dL, 95% CI: -1.02 to -0.09; I2 = 94%), Both doses (≤ 2 g/day and ≥ 2 g/day) decreased fasting blood glucose and postprandial glucose. (De Moura, 2024). Thus, cinnamon significantly reduces FBS, (HbA1c), and postprandial glucose. It also improves insulin sensitivity markers, making it a strong candidate for glycemic control, table (5, 6).

 Table (2) Effects of bioactive components of cinnamon on blood sugar and metabolic markers

Author	Year	Bioactive Compounds
(Olefsky, 2000) (Rachid, <i>et al.</i> , 2022)	Polyphenols (glucuronides and proanthocyanidins)	- It enhances the phosphorylation activity of insulin receptors and lowers tyrosine phosphatase activity.
(Xie <i>et al.</i> , 2023)		- It improves glucose absorption and glycogen production.
(Stockert <i>et al.</i> , 2022)	Sirtuin	-It is important for maintaining glucose homeostasis.

Fenugreek

Scientific Name of fenugreek is *Trigonella foenum-graecum* L (Velázquez *et al.*, 2023) (fig. 3), it is frequently used as an herbal medicine for the management of diabetes. Its effectiveness in the diabetes population is explained by a number of reasons. The soluble fibers in fenugreek, such as glucomannan fiber, slow down the intestinal absorption of carbohydrates that are consumed. Additionally, alkaloids, such as fenugrecin and trigonelline, have been shown to have hypoglycemic properties, while the amino acid 4-hydroxyisoleucine (4-OH Ile) stimulates the pancreas to release insulin (Ranade & Mudgalkar, 2017).Therefore, supporting the idea that low-glycemic diets with high soluble fiber levels lower blood glucose levels in diabetic patients by confirming an inverse

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relationship between fenugreek seed consumption and glucose resistance (Phadnis *et al.*, 2011), table (3).



Figure (3). Fenugreek (Dhakad et al., 2023)

Hadi *et al.*, (2020) reported on an 8-week controlled clinical research involving 50 patients with type 2 diabetes who were treated with anti-diabetic medications. Patients were given either 5 g of fenugreek seed powder three times daily or served as control patients. Compared to control patients, treated patients exhibited a significant decrease in fasting plasma glucose (p = 0.024). The exposed group was given 10 g of powdered fenugreek seeds steeped in water every day for 60 days, while the control group received no test diet. Patients' blood glucose levels were strongly linked with fenugreek supplementation (p < 0.001) and type of therapy (p < 0.05), even after controlling for demographics, physical conditions, and medical history.

The exposed group's fasting and postprandial blood glucose levels were 2.38 mmol/L (95% CI:-3.45,-1.32, p < 0.001) and 4.18 mmol/L (95% CI:-5.41,-2.95, p < 0.001, respectively), considerably lower than the control group. The decrease of blood glucose levels in the exposed group occurred gradually over time, whereas significant alterations were noticed after 30 days of supplements (Khatun *et al.*, 2023). After 12 weeks of fenugreek treatment, fasting and postprandial serum glucose levels had lowered by 38 and 44%, respectively. Simultaneously, a significant 34.7% drop in glycated hemoglobin was observed (Gupta *et al.*, 2024), table (5, 6). Hence, Fenugreek reduces (FBS), postprandial glucose, and (HbA1c) levels



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substantially, with the benefits becoming greater with extended intake.

Table (3) Effects of bioactive components of fenugreek on blood sugar
and metabolic markers

Author & Year	Bioactive components Effects	
(Ranade & Mudgalkar, 2017) (Al Mosawi, 2021)	glucomannan fiber	-It slows down the intestinal absorption of carbohydrates that are consumed.
(Singh, <i>et al.</i> , 2023)(Sarker <i>et al.</i> , 2024) (Asghar, 2024)	fenugrecin and trigonelline	- They have hypoglycemic properties.
(Tak <i>et al.</i> , 2024) (Sarker <i>et al.</i> , 2024)	Diosgenin	- It promotes glucose transporter type-4 (GLUT4) translocation, hence boosting glucose absorption in cells.
(Ranade & Mudgalkar, 2017) (Al Mosawi, 2021) (Singh, <i>et al.</i> , 2023). (Luo <i>et al.</i> , 2023).	4-Hydroxyisoleucine	 -It stimulates the pancreas to release insulin. - It increases insulin secretion and improves insulin sensitivity. - It has anti-inflammatory and antioxidant effects, which protect pancreatic β- cells from harm.

Flaxseed

The botanical name of flaxseed (fig. 4) is *Linum usitatissimum* L (Shim *et al.*, 2014) and there is not much research that shows how supplementing with flaxseed can help diabetes patients' oxidative stress, glycemic status, and inflammation (Pan *et al.*, 2007) In research including individuals with insulin resistance, flaxseed considerably improved glycemic control (Rhee *et al.*, 2011) Because of its abundance in lignans, dietary fiber, alpha-linolenic acid (ALA), and other compounds that may be healthful, flaxseed



has gained interest as a functional food (Ursoniu *et al.*, 2016), table (4).



Figure (4). Flaxseed (Batool et al., 2024)

A study showed in the flaxseed group, the peak glucose increase and 2-hour AUC glycemic response decreased by 17% (p = 0.001) and 24% (p < 0.001), respectively. The glucose peak time, palatability, and taste parameters were the same between the two groups. Conclusions: Consuming 15 g of ground raw golden flaxseed before breakfast reduces the 2-hour postprandial glycemic response in males with T2DM (Moreira et al., 2021). In another study, flaxseed supplementation significantly reduced (FBS) Standardized the Difference of Mean between groups (SMD: -0.66; 95% CI: -0.96, -0.35), (HOMA-IR) and Quantitative Insulin Sensitivity Check Index (QUICKI scores) (SMD: -0.64; 95% CI: -1.02, -0.26), and insulin (SMD: -0.49; 95% CI: -0.80, -0.17), according to findings from 4725 randomized clinical studies (RCTs). Moreover, QUICKI increased significantly (SMD: 1.64; 95% CI: 1.13, 2.14) following flaxseed supplementation. Flaxseed had no significant effect on (HbA1c) levels (SMD: -0.47; 95% CI: -0.97, 0.04) (Kavyani et al., 2023). However, (Andrea et al., 2022) reported that flaxseed significantly decreased (HbA1c) levels. A total of 25 (RCs) (30 treatment arms) were considered. Metaanalysis suggested a significant association between flaxseed supplementation and reduction in blood a glucose [WMD], -2.94 mg/dL; 95%CI, -5.31 to - 0.56; P = 0.015), insulin levels (WMD, -7.32 pmol/L; 95%CI, -11.66 to -2.97; P = 0.001), and HOMA-IR index (WMD, -0.49; 95%CI.: -0.78 to -0.20;



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P = 0.001) and an increase in QUIKI index (WMD, 0.019; 95%CI, 0.008-0.031; P = 0.001). There was no significant effect on (HbA1c) levels (WMD, -0.045%; 95%CI, -0.16 to -0.07; P=0.468). As aresult, flaxseed lowers (FBS) and improves insulin sensitivity but has mixed results on (HbA1c), with whole flaxseed with a larger dose being more effective than flaxseed extracts, table (5, 6).

Table (4) Effects of bioactive components of flaxseed on blood sugar
and metabolic markers

Author & Year	Bioactive components	Effects
(Pan <i>et al.,</i> 2009)(Ursoniu et al 2016) (Nowak & Jeziorek, 2023)(Mishra, 2021)	Alpha- Linolenic Acid (ALA)	-It Lowers insulin sensitivity via regulating hormone secretion, enhancing insulin signaling, and encouraging β cells to produce insulin. -Its omega-3 fatty acid has anti- inflammatory characteristics, which can increase insulin sensitivity and reduce fasting glucose levels.
(Maurya, 2024) (Mishra, 2021).	Lignans and α-linolenic acid	- It may help in decreasing blood sugar levels due to its antioxidant effects.
(Wioletta <i>et al.</i> , 2023) (Nowak & Jeziorek, 2023)(Mishra, 2021).	Dietary Fiber	-Its high fiber content leads to slower glucose absorption, resulting in more stable blood sugar levels.



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Table (5) the comparative optimal dose and efficacy of four herbs in					
reducing blood sugar levels in diabetic patients					
Herb Author & The optimal Outcome					
	Voor	each			

Herb	Author & Year	The optimal dose	Outcome
	(Zamany <i>et</i> al., 2022). (Rajeshwar	1g/day	-(FBS) from 156.15 to 130.30 mg/dL -This trial also reported changes in insulin levels
Coriander	(Rajeshwar i, 2011).	Not reported	and other metabolic markers.
Cor		4.5 g/day	- Its effective
	(Akbar & Munir, 2006).		hypoglycemic activity when combined with oral hypoglycemic agents.
	(Aldayel, 2016).	5 g/day	- There were no significant variations in glucose responses.
Cinnamon	(Moura et al., 2024).	2 g/day	- In comparison to larger doses, it dramatically reduces fasting blood glucose,
	(Antônio <i>et</i> <i>al.</i> , 2021).	2 g/day	postprandial glucose, HbA1c. - A considerable drop in fasting plasma glucose levels.
	(Al Mosawi, 2021).	15g/day	-It significantly reduced HbA1C and postprandial glucose levels. - It provides significant
Fenugreek	(Khatun <i>et</i> <i>al.</i> , 2023).	10 g/day	benefits in glycemic control at these dosages.
	(Gupta <i>et</i> <i>al.</i> , 2024).	1g/day	- Reductions in fasting blood glucose (FBG) and postprandial blood glucose (PBG).
	, ,.		- It successfully regulates blood sugar levels in individuals.





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Haxseed Haxsee	Yari <i>et al.</i> , (2019) (Almehma di <i>et al.</i> , (2021). (Andrea, <i>et al.</i> , (2022). (Kavyani <i>et al.</i> , (2023). (Mohamm adi- Sartang <i>et al.</i> , 2018).	30 g/day	 Consuming flaxseed in split amounts was proven to reduce and stabilize blood glucose responses over 24 hours compared to control groups. Whole flaxseed outperformed flaxseed oil or lignan extracts in terms of improving glycemic markers
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Table (6) the comparative of four herbs in reducing blood sugar levels in diabetics

Herb	Fasting Blood Glucose (FBG)	Postprandia 1 Glucose	HbA1c (%)	Insulin Sensitivity/Resist
		(PPG)		ance (HOMA-IR, QUICKI)
Coriander	↓ 156.15 to 130.30 mg/dL (seeds).	Not reported	No significan t change.	↓ HOMA-IR (6.82 to 5.52), serum insulin (17.72 to 17.12)
Cinnamon	↓ 126.67 mg/dL (mean drop significant); MD: -18.43 mg/dL	↓ 39.22 mg/dL	↓ 0.56%	↓ HOMA-IR (MD: -0.76)
Fenugreek	↓ 38-44% FBG	↓ 44%	↓ 34.7%	↑Improves insulin resistance
Flaxseed	↓ 2.94 mg/dL; SMD: -0.66	↓ 24%	↓ 0.045%	↑ QUICKI (SMD: 1.64);↓ HOMA-IR (SMD: -0.49)

Conclusion

An extensive study has demonstrated the possibility of using traditional herbs and spices to control blood glucose. These could be attributed to the synergistic action of its bioactive compounds. However, the efficiency of these natural remedies differs based on form, dosage, study design, and patient characteristics. Herbs, such as coriander, cinnamon, fenugreek, and flaxseed have shown

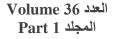


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significant potential, but the degree of improvement in markers, including HbA1c and postprandial glucose requires further investigation. The study findings indicated coriander has the strongest overall effect on blood sugar reduction with the least dose whereas flaxseed has the least impact with the highest dose on blood sugar reduction among herbs under investigation additionally, variations in study designs, sample sizes, and methodologies limit the generalizability of findings. According to published findings, medical plants are more inexpensive, have fewer side effects than synthetic medications, and are more successful in treating diabetes mellitus. Nonetheless, more extensive research with superior designs and a long study is required to validate negligible and/or unclear results.

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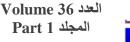




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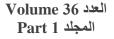
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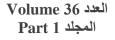




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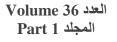




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